EVERYDAY ELECTRONICS

DECEMBER 1991

2G G 100192
BRENTFORD SQ
NEWS 878-1882
3 $4.95

INCORPORATING ELECTRONICS MONTHLY

£1.60

MIND MACHINE

AUDIO/VISUAL ENTRAINMENT UNIT

SIGNAL GENERATOR

0.1Hz TO 100kHz; SINE, SQUARE, TRIANGLE

FREE INSIDE

48 PAGE GREENWELD BARGAIN LIST

12

9 770262 361027

HE No. 1 INDEPENDENT MAGAZINE for ELECTRONICS, TECHNOLOGY and COMPUTER PROJECTS

UNIDEN SATELLITE RECEIVER Brand new units (model 8008) £60.00 ref 60P4V also some 7007s also £60.00 ref 60P5V

SPECTRUM +2 COMPUTER Built in data recorder, 128K, psu and manuals £59.00 ref 59P4V

SPECTRUM +3 COMPUTER Built in disc drive, 128K, psu and manuals £79.00 ref 79P4V

AMSTRAD CPC464 COMPUTER No manuals but only £79.00 ref 79P5V

AMSTRAD CPC6128 COMPUTER Again no manuals but only £149.00 ref 149P4V

AMSTRAD GT65 Green screen monitor £49.00 ref 49P4V

AMSTRAD PORTABLE PC'S FROM £149 (PPC1512SD). £179 (PPC1512DD). £179 (PPC1640SD). £209 (PPC1640DD). MODEMS £30 EXTRA.NO MANUALS OR PSU.

AMSTRAD PC BARGAIN!!!!!!

PC 1512DD COMPLETE WITH CGA COLOUR MONITOR, 2 DISC DRIVES, MANUALS ETC ONLY £249.00 REF 249P4V

HIGH POWER CAR SPEAKERS. Stereo pair output 100w each. 4ohm impedance and consisting of 6 1/2" woofer 2" mid range and 1" tweeter. Ideal to work with the amplifier described above. Price per pair £30.00 Order ref 30P7V.

2KV 500 WATT TRANSFORMERS Suitable for high voltage experiments or as a spare for a microwave oven etc. 250v AC input. £10.00 ref 10P93V

MICROWAVE CONTROL PANEL. Mains operated, with touch switches. Complete with 4 digit display, digital clock, and 2 relay outputs one for power and one for pulsed power (programmable). Ideal for all sorts of precision timer applications etc. £6.00 ref 6P18V

FIBRE OPTIC CABLE. Stranded optical fibres sheathed in black PVC. Five metre length £7.00 ref 7P29V

12V SOLAR CELL. 200mA output ideal for trickle charging etc. 300 mm square. Our price £15.00 ref 15P42V

PASSIVE INFRA-RED MOTION SENSOR. Complete with daylight sensor, adjustable lights on timer (8 secs -15 mins), 50' range with a 90 deg coverage. Manual overide facility. Complete with wall brackets, bulb holders etc. Brand new and guaranteed. £25.00 ref 25P24V.

Pack of two PAR38 bulbs for above unit £12.00 ref 12P43V

VIDEO SENDER UNIT Transmit both audio and video signals from either a video camera, video recorder or computer to any standard TV set within a 100' range! (tune TV to a spare channel). 12v DC op. £15.00 ref 15P39V Suitable mains adaptor £5.00 ref 5P191V

FM TRANSMITTER housed in a standard working 13A adapter (bug is mains driven). £26.00 ref 26P2V

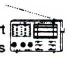
MINATURE RADIO TRANSCEIVERS A pair of walkie talkies with a range of up to 2 kilometres. Units measure 22x52x155mm. Complete with cases. £30.00 ref 30P12V

FM CORDLESS MICROPHONE. Small hand held unit with a 500' range! 2 transmit power levels reqs PP3 battery. Tuneable to any FM receiver. Our price £15 ref 15P42AV

---

10 BAND COMMUNICATIONS RECEIVER. 7 short bands, FM, AM and LW DX/local switch, tuning 'eye' mains or battery. Complete with shoulder strap and mains lead

NOW ONLY £19.00!! REF 19P14V.



WHISPER 2000 LISTENING AID. Enables you to hear sounds that would otherwise be inaudible! Complete with headphones. Cased. £5.00 ref 5P179V.

CAR STEREO AND FM RADIO Low cost stereo system giving 5 watts per channel. Signal to noise ratio better than 45db, wow and flutter less than .35%. Neg earth. £25.00 ref 25P21V.

LOW COST WALIKIE TALKIES. Pair of battery operated units with a range of about 150'. Our price £8.00 a pair ref 8P50V

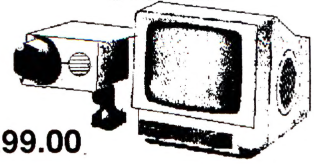
7 CHANNEL GRAPHIC EQUALIZER plus a 60 watt power amp! 20-21KHZ 4-8R 12-14v DC negative earth. Cased. £25 ref 25P14V.

NICAD BATTERIES. Brand new top quality. 4 x AA's £4.00 ref 4P44V. 2 x C's £4.00 ref 4P73V, 4 x D's £9.00 ref 9P12V, 1 x PP3 £6.00 ref 6P35V

TOWERS INTERNATIONAL TRANSISTOR SELECTOR GUIDE. The ultimate equivalents book. Latest edition £20.00 ref 20P32V.

CABLE TIES. 142mm x 3.2mm white nylon pack of 100 £3.00 ref 3P104V. Bumper pack of 1,000 ties £14.00 ref 14P6V

VIDEO AND AUDIO MONITORING SYSTEM



£99.00

Brand new units consisting of a camera, 14cm monitor, 70 metres of cable, AC adapter, mounting bracket and owners manual. 240v AC or 12v DC operation complete with built in 2 way intercom. **£99.00** ref 99P2v.

1991 CATALOGUE AVAILABLE NOW IF YOU DO NOT HAVE A COPY PLEASE REQUEST ONE WHEN ORDERING OR SEND US A 6"X9" SAE FOR A FREE COPY.

GEIGER COUNTER KIT. Complete with tube, PCB and all components to build a battery operated geiger counter. £39.00 ref 39P1v

FM BUG KIT. New design with PCB embedded coil. Transmits to any FM radio. 9v battery req'd. £5.00 ref 5P158V

FM BUG Built and tested superior 9v operation £14.00 ref 14P3V

COMPOSITE VIDEO KITS. These convert composite video into separate H sync, V sync and video. 12v DC. £8.00 ref 8P39V.

SINCLAIR C5 MOTORS 12v 29A (full load) 3300 rpm 6"x4" 1/4" O/P shaft. New. £20.00 ref 20P22V.

As above but with fitted 4 to 1 inline reduction box (800rpm) and toothed nylon belt drive cog £40.00 ref 40P8V.

SINCLAIR C5 WHEELS 13" or 16" dia including treaded tyre and inner tube. Wheels are black, spoked one piece poly carbonate. 13" wheel £6.00 ref 6P20, 16" wheel £6.00 ref 6P21V.

ELECTRONIC SPEED CONTROL KIT for c5 motor. PCB and all components to build a speed controller (0-95% of speed). Uses pulse width modulation. £17.00 ref 17P3V.

SOLAR POWERED NICAD CHARGER. Charges 4 AA nicads in 8 hours. Brand new and cased £6.00 ref 6P3V.

AT 286 MOTHER BOARD

640K RAM

UPGRADABLE TO 4 M

AT CASE

AT POWER SUPPLY

AT KEYBOARD

MANUAL

NO I/O CARDS

£139

ELECTRONIC TICKET MACHINES These units contain a magnetic card reader, two matrix printers, motors, sensors and loads of electronic components etc. (12"x12"x7") Good value at £12.00 ref 12P28V.

JOYSTICKS. Brand new with 2 fire buttons and suction feet these units can be modified for most computers by changing the connector etc. Price is 2 for £5.00 ref 5P174V.

GAS POWERED SOLDERING IRON AND BLOW TORCH Top quality tool with interchangeable heads and metal body. Fully adjustable, runs on lighter gas.£10.00 ref 10P130V

ANSWER MACHINES BT approved remote message playback, intergral push button phone, power supply and tape. Exceptional value at £45.00 ref 45P2V

CAR IONIZER KIT Improve the air in your car! clears smoke and helps to reduce fatigue. Case required. £12.00 ref 12P8V.

6V 10AH LEAD ACID sealed battery by yuasha ex equipment but in excellent condition now only 2 for £10.00 ref 10P95V.

12 TO 220V INVERTER KIT As supplied it will handle up to about 15 w at 220v but with a larger transformer it will handle 80 watts. Basic kit £12.00 ref 12P17. Larger transformer £12.00 ref 12P41V.

VERO EASI WIRE PROTOTYPING SYSTEM Ideal for designing projects on etc. Complete with tools, wire and reusable board. Our price £6.00 ref 6P33V.

MICROWAVE TURNTABLE MOTORS. Ideal for window displays etc. £5.00 ref 5P165V.

STC SWITCHED MODE POWER SUPPLY 220v or 110v input giving 5v at 2A, +24v at 0.25A, +12v at 0.15A and +90v at 0.4A £6.00 ref 6P59V

HIGH RESOLUTION 12" AMBER MONITOR 12v 1.5A Hercules compatible (TTL input) new and cased £22.00 ref 22P2V

VGA PAPER WHITE MONO monitors new and cased 240v AC. £59.00 ref 59P4V

25 WATT STEREO AMPLIFIER c. STK043. With the addition of a handful of components you can build a 25 watt amplifier. £4.00 ref 4P69V (Circuit dia included).

LINEAR POWER SUPPLY Brand new 220v input +5 at 3A, +12 at 1A, -12 at 1A. Short circuit protected. £12.00 ref 12P21V.

MAINS FANS Snail type construction. Approx 4"x5" mounted on a metal plate for easy fixing. New £5.00 5P166V.

POWERFUL IONIZER KIT. Generates 10 times more ions than commercial units! Complete kit including case £18.00 ref 18P2V.

MINI RADIO MODULE Only 2" square with ferrite aerial and tuner. Superhet. Req's PP3 battery. £1.00 ref BD716V.

HIGH RESOLUTION MONITOR. 9" black and white Phillips tube in chassis made for OPD computer but may be suitable for others. £20.00 ref 20P26V.

BARGAIN NICADS AAA SIZE 200MAH 1.2V PACK OF 10 £4.00 REF 4P92V, PACK OF 100 £30.00 REF 30P16V

CB CONVERTORS. Converts a car radio into an AM CB receiver. Cased with circuit diagram. £4.00 ref 4P48V.

FLOPPY DISCS. Pack of 15 31/2" DSDD £10.00 ref 10P88V. Pack of 10 51/4" DSDD £5.00 ref 5P168V.

BULL ELECTRICAL

250 PORTLAND ROAD HOVE SUSSEX
BN3 5QT TELEPHONE 0273 203500
MAIL ORDER TERMS: CASH PO OR CHEQUE
WITH ORDER PLUS £2.50 POST PLUS VAT.
PLEASE ALLOW 10-14 DAYS FOR DELIVERY
NEXT DAY DELIVERY £8.00
FAX 0273 23077

VISA

SONIC CONTROLLED MOTOR One click to start, two click to reverse direction, 3 click to stop! £3.00 each ref 3P137V.

FRESNEL MAGNIFYING LENS 83 x 52mm £1.00 ref BD827V.

LCD DISPLAY. 4 1/2 digits supplied with connection data £3.00 ref 3P77V or 5 for £10.00 ref 10P78V.

ALARM TRANSMITTERS. No data avaliable but nicely made complex transmitters 9v operation. £4.00 each ref 4P81V.

100M REEL OF WHITE BELL WIRE figure 8 pattern ideal for intercoms, door bells etc £3.00 a reel ref 3P107V.

TRANSMITTER RECEIVER SYSTEM originally made for nurse call systems they consist of a pendant style transmitter and a receiver with telescopic aerial 12v. 80 different channels. £12.00 ref 12P26V

CLAP LIGHT. This device turns on a lamp at a finger 'snap' etc. nicely cased with built in battery operated light. Ideal bedside light etc £4.00 each ref 4P82V.

ELECTRONIC DIPSTICK KIT. Contains all you need to build an electronic device to give a 10 level liquid indicator. £5.00 (ex case) ref 5P194V.

UNIVERSAL BATTERY CHARGER. Takes AA's, C's, D's and PP3 nicads. Holds up to 5 batteries at once. New and cased, mains operated. £6.00 ref 6P36V.

ONE THOUSAND CABLE TIES! 75mm x 2.4mm white nylon cable ties only £5.00 ref 5P181V.

PC MODEMS 1200/75 baud modems designed to plug into a PC complete with manual but no software £18.00 ref 18P12V

ASTEC SWITCHED MODE POWER SUPPLY 80mm x 165mm (PCB size) gives +5 at 3.75A, +12 at 1.5A, -12 at 0.4A. Brand new £12.00 ref 12P39V.

VENTILATED CASE FOR ABOVE PSU with IEC filtered socket and power switch. £5.00 ref 5P190V.

IN CAR POWER SUPPLY. Plugs into cigar socket and gives 3,4,5,6,7.5,9, and 12v outputs at 800mA. Complete with universal spider plug. £5.00 ref 5P167V.

CUSTOMER RETURNED switched mode power supplies. Mixed type, good for spares or repair. £2.00 each ref 2P292V.

DRILL OPERATED PUMP. Fits any drill and is self priming. £3.00 ref 3P140V.

PERSONAL ATTACK ALARM. Complete with built in torch and vanity mirror. Pocket sized, req's 3 AA batteries. £3.00 ref 3P135V

POWERFUL SOLAR CELL 1AMP .45 VOLT only £5.00 ref 5P192V (other sizes avaliable in catalogue).

SOLAR PROJECT KIT. Consists of a solar cell, special DC motor, plastic fan and turntables etc plus a 20 page book on solar energy! Price is £8.00 ref 8P51V.

RESISTOR PACK. 10 x 50 values (500 resistors) all 1/4 watt 2% metal film. £5.00 ref 5P170V.

CAPACITOR PACK 1. 100 assorted non electrolytic capacitors £2.00 ref 2P286V.

CAPACITOR PACK 2. 40 assorted electrolytic capacitors £2.00 ref 2P287V.

QUICK CUPPA? 12v immersion heater with lead and cigar lighter plug £3.00 ref 3P92V.

LED PACK .50 red leds, 50 green leds and 50 yellow leds all 5mm £8.00 ref 8P52V

FERRARI TESTAROSSA. A true 2 channel radio controlled car with forward, reverse, 2 gears plus turbo. Working headlights. £22.00 ref 22P6V.

ULTRASONIC WIRELESS ALARM SYSTEM Two units, one a sensor which plugs into a 13A socket in the area you wish to protect. The other, a central alarm unit plugs into any other socket elsewere in the building. When the sensor is triggered (by body movement etc) the alarm sounds. Adjustable sensitivity. Price per pair £20.00 ref 20P34V. Additional sensors (max 5 per alarm unit) £11.00 ref 11P6V.

WASHING MACHINE PUMP. Mains operated new pump. Not self priming £5.00 ref 5P18V.

IBM PRINTER LEAD. (D25 to centronics plug) 2 metre parallel. £5.00 ref 5P186V.

COPPER CLAD STRIP BOARD 17" x 4" of .1" pitch "vero" board. £4.00 a sheet ref 4P62V or 2 sheets for £7.00 ref 7P22V.

STRIP BOARD CUTTING TOOL. £2.00 ref 2P352V.

3 1/2" disc drive. 720K capacity made by NEC £60.00 ref 60P2V

TV LOUDSPEAKERS. 5 watt magnetically screened 4 ohm 55 x 125mm. £3.00 a pair ref 3P109V.

SPEAKER GRILLS set of 3 matching grills of different diameters. 2 packs for £2.00 (6 grills) ref 2P364V

50 METRES OF MAINS CABLE £3.00 2 core black precut in convenient 2 m lengths. Ideal for repairs and projects. ref 3P91V

4 CORE SCREENED AUDIO CABLE 24 METRES £2.00 Precut into convenient 1.2 m lengths. Ref 2P365V

TWEETERS 2 1/4" DIA 8 ohm mounted on a smart metal plate for easy fixing £2.00 ref 2P366V

COMPUTER MICE Originally made for Future PC's but can be adapted for other machines. Swiss made £8.00 ref 8P57. Atari ST conversion kit £2.00 ref 2P362V.

6 1/2" 20 WATT SPEAKER Built in tweeter 4 ohm £5.00 ref 5P205V

5" X 3" 16 OHM SPEAKER 3 for £1.00!! ref CD213V

ADJUSTABLE SPEAKER BRACKETS Ideal for mounting speakers on internal or external corners, uneven surfaces etc. 2 for £5.00 ref 5P207V

PIR LIGHT SWITCH Replaces a standard light switch in seconds light operates when anybody comes within detection range (4m) and stays on for an adjustable time (15 secs to 15 mins). Complete with daylight sensor. Unit also functions as a dimmer switch! 200 watt max. Not suitable for flourescents. £14.00 ref 14P10V

2 MEG DISC DRIVES 3 1/2" disc drives made by Sony housed in a 5 1/4" frame 1.2 meg formatted. £66.00 ref 66P1V.

CUSTOMER RETURNED 2 channel full function radio controlled cars only £8.00 ref 8P200V

WINDUP SOLAR POWERED RADIO! FM/AM radio takes NICAD batteries complete with hand charger and solar panel 14P200V

240 WATT RMS AMP KIT Stereo 30-0-30 psu required £40.00 ref 40P200V

300 WATT RMS MONO AMP KIT £55.00 Psu required ref 55P200V

ALARM PIR SENSORS Standard 12v alarm type sensor will interface to most alarm panels. £16.00 ref 16P200V

ALARM PANELS 2 zone cased keypad entry, entry exit time delay etc. £18.00 ref 18P200V

35MM CAMERAS Customer returned units with built in flash and 28mm lens **2 for £8.00** ref 8P200V

STEAM ENGINE Standard Mamod 1332 engine with boiler piston etc £30ref 30P200V

SOME OF OUR PRODUCTS MAY BE UNLICENSABLE IN THE UK

VOL. 20 No. 12 DECEMBER 1991

EVERYDAY ELECTRONICS

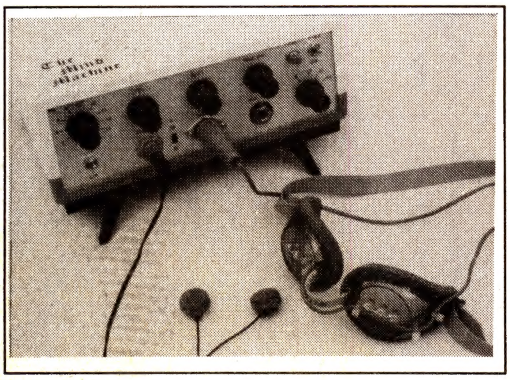
INCORPORATING ELECTRONICS MONTHLY

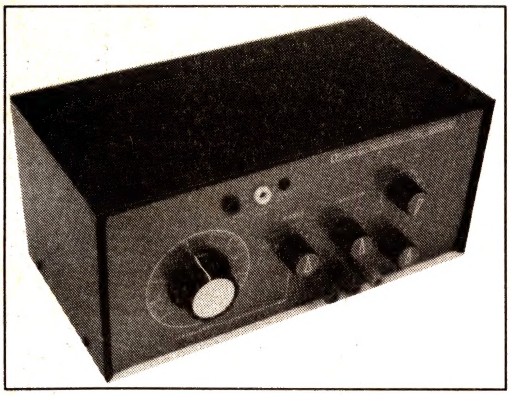
ABC
MEMBER OF THE AUDIT BUREAU OF CIRCULATIONS

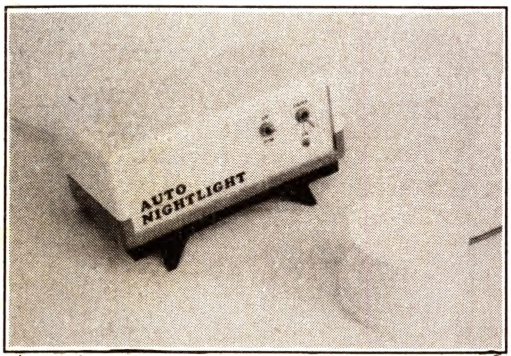
The No 1 Magazine for Electronic & Computer Projects

ISSN 0262 3617

PROJECTS . . . THEORY . . . NEWS . . .
COMMENT . . . POPULAR FEATURES . . .







© Wimborne Publishing Ltd 1991. Copyright in all drawings, photographs and articles published in EVERYDAY ELECTRONICS is fully protected, and reproduction or imitations in whole or in part are expressly forbidden.

Our January '92 Issue will be published on Friday, 6 December 1991. See page 755 for details.

Projects

SIGNAL GENERATOR by Steve Knight 764
Sine, square and triangle output with good stability and accuracy

MIND MACHINE by Andy Flind 782
Photic and binaural entrainment unit

SIMPLE MODEL SERIES
6 – CHRISTMAS DECORATION by Owen Bishop 791
A novelty with flashing lights and festive tunes

AUTO NIGHTLIGHT by Alan Winstanley 800
Automatically dims a "safe" nightlight

KNOCKERBOX by David Smith 814
When you press the doorbell a knocker "raps" on the door

Series

ACTUALLY DOING IT by Robert Penfold 774
Making your own printed circuit boards

MAGNETIC RECORDING by Vivian Capel 796
Part Three: Head Maintainance and Adjustment

INTERFACE by Robert Penfold 804
The spot for all computer enthusiasts – 8 bit A to D

INFORMATION TECHNOLOGY AND THE NATIONAL CURRICULUM by T. R. de Vaux-Balbirnie 806
Part Two: The electric telegraph

AMATEUR RADIO by Tony Smith G4FAI 812
Ham Radio and the Coup; Launch Confirmed; NiCad Care; Sangean Servicing.

Features

EDITORIAL 763

FOR YOUR ENTERTAINMENT by Barry Fox 776
Old Idea – New Batteries; New Idea – Old Batteries; Will Rabbit run for Hutch?

DOWN TO EARTH by George Hylton 779
Adding with amplifiers

SHOPTALK with David Barrington 780
Component buying for EE projects

SIMPLE MODELS SERIES SPECIAL EASIWIRE OFFER 790

ROBOT ROUNDUP by Nigel Clark 818
News from the world of robotics

DIRECT BOOK SERVICE 820
Selected technical books and all the EE books by mail order

PRINTED CIRCUIT BOARD SERVICE 824
P.C.B.s for EE projects

INDEX FOR 1991 – VOLUME 20 826

FREE WITH THIS ISSUE

Greenweld Electronics Bargain List, between pages 792 and 793

ADVERTISER'S INDEX ***832***

Readers Services • Editorial and Advertisement Departments 763

HARD DISC DRIVES

20 Mb (IDE - CONNER)	£ 79
20 Mb (MFM or RLL)	£ 79
40 Mb (IDE)	£ 140
100 Mb (IDE - CONNER)	£235
MOUNTING KIT (INCLUDING BEZELS & LED)	£ 9
MOUNTING KIT (MOUNTING RAILS ONLY)	£ 5

HARDCARDS

20 Mb	AT	£105
20 Mb	XT	£120
40 Mb	AT	£170
40 Mb	XT	£185
100 Mb	AT	£265

HARDCARD KIT

CONVERT YOUR 3½" HARD DISC DRIVE TO A HARDCARD. £ 16

FLOPPY DISC DRIVES

3½"	1.44M	INTERNAL	£ 40
3½"	1.44M	EXTERNAL	£ 49
3½"	720K	INTERNAL	£ 33
3½"	720K	EXTERNAL	£ 44
5¼"	1.2M	INTERNAL	£ 45
5¼"	1.2M	EXTERNAL	£ 50
5¼"	360K	EXTERNAL	£ 29

MONITORS

14" VGA COLOUR 0.31 DOT PITCH TILT & SWIVEL BASE	£ 153
12" VGA PAPER WHITE MONITOR TILT & SWIVEL BASE	£ 75

KEYBOARD

AT 102 KEY - UK - IBM CLICK £24

ACCESSORIES

5¼" ADAPTOR KIT FOR 3½" FDD	£ 8.00
5¼" TRAY FOR 3½" FDD	£ 5.50
POWER LEAD FOR 3½" FDD	£ 3.00
IDC PIN TO EDGE CONNECTOR PCB	£ 4.00
SHORT F D D CONTROLLER CABLE 2'	£ 4.00
LONG F D D CONTROLLER CABLE 4'	£ 7.00
POWER SPLITTER	£ 4.50
HARD DRIVE CABLES (MFM/RLL)	£ 6.00
IDE HARD DRIVE CABLE (2 DRIVES)	£ 6.00
KEYBOARD EXTENSION CABLE	£ 4.00

ADD ON CARDS

FDD CONTROLLER - 2xFDD - ANY FORMAT	£ 25
VGA CARD - 8 / 16 BIT - 256K	£ 43
TRIDENT SUPER VGA - 16BIT - 512K	£ 60
2 SERIAL / 1 PARALLEL / 1 GAMES PORT	£ 19
4 MB RAM CARD FOR AT WITH EMS USES 256K OR 1M - WITHOUT RAM	£ 57

CONTROLLER CARDS

IDE - AT 16BIT-2HDD/2FDD	£ 17
IDE - AT 16BIT-2HDD/2FDD/2S/1P/1G	£ 26
IDE - 8 BIT-XT / AT / 1512	£ 29
AT RLL - 2 x HDD	£ 25
AT MFM - 2 x HDD / 2 x FDD	£ 44
AT RLL - 2 x HDD / 2 x FDD	£ 40

MOTHERBOARDS

AMI BIOS - EMS 4.0 - SHADOW RAM

★ COMPLETE WITH 1 Mb MEMORY ★

286 - 16	L/S 21 MHz	£ 105
286 - 20	L/S 25 MHz	£ 125
386SX- 25	L/S 31 MHz	£ 225

386 & 486 AVAILABLE - PLEASE CALL

COMPUTER CASES

COMPLETE WITH 200W P.S.U

FLIP-TOP	WITH 3 BAYS	£ 60
DESKTOP	WITH 4 BAYS	£ 80
MINI TOWER	WITH 5 BAYS	£ 70
FULL TOWER	WITH 6 BAYS	£ 107

SPECIAL OFFER

286 - 16 SYSTEM

● FEATURES INCLUDE ●

- 286-16 (L/S 21MHZ)
- 1 Mb ON BOARD MEMORY
- 20 Mb HARD DISC IDE
- 3½" 1.44M FLOPPY
- HDD / FDD CONTROLLER
- 2S / 1P / 1G
- VGA CARD (256K)
- KEYBOARD (102 KEYS)
- MINI TOWER CASE
- CHOICE OF MONITOR

12" VGA PAPER WHITE	£ 460
14" VGA COLOUR	£ 545

LET HOBBYKIT QUOTE FOR YOUR COMPUTER SYSTEM

HOBBYKIT

CREDIT CARD HOTLINE

☎ 081 - 205 7485

UNIT 19 CAPITOL INDUSTRIAL PARK
CAPITOL WAY, LONDON, NW9 0EQ
FAX NUMBER : 081 - 205 0603

END OF LINES

MODEMS - V22 BIS - 2400 BPS
AUTO DIAL - AUTO ANSWER - FULL DUPLEX
AUTO REDIAL - TONE & PULSE DIALING
BT APPROVAL - BABT APPROVAL
SUPPLIED WITH EAZILINK COMMS PACKAGE
MC2400 - INTERNAL £ 65

3½" - 720K EXT FLOPPY DISC DRIVE
NEW - GREY CASE
SPECIAL OFFER PRICE £ 26

3½" - 1.44 M INT FLOPPY DISC DRIVE
BLACK ONLY
SPECIAL OFFER PRICE £ 39

5¼" - 360K INT FLOPPY DISC DRIVE
NEW - GREY OR BLACK
SPECIAL OFFER PRICE £ 24

CGA CARD - FULL LENGTH -
COMPOSITE & TTL £ 12

60 MEG TAPE STREAMER

DC600 - 5¼" TRAY
SUITABLE FOR ALL IBM COMPATIBLES
PRICE : £ 150

●● ALL PRICES INCLUDE V A T ●●

FDD EXTERNAL CASES

METAL GREY CASE SUITABLE FOR EXTERNAL MOUNTING OF FLOPPY DISC DRIVES, HARD DISC DRIVES, TAPE STREAMERS, CD ROMS ETC

5¼" CASE ONLY	£ 8
5¼" CASE + LEADS FOR F D D	£ 17
3½" CASE ONLY	£ 8
3½" CASE + LEADS FOR F D D	£ 20

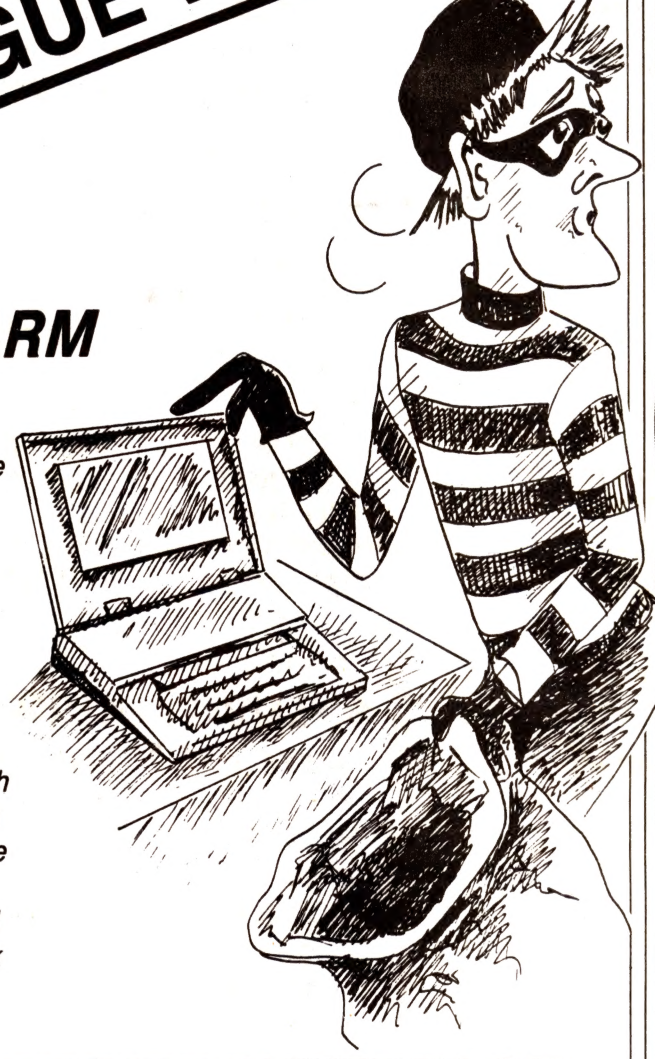
3 STATION NETWORK SYSTEM

ALL PARTS FOR 3 STATIONS SUPPLIED INCLUDING DRIVER SOFTWARE AND DATA. USES TWISTED PAIR CABLE - EXPANDABLE. EASY INSTALLATION - APPROX 30 MINS. 1 Mb TRANSFER RATE. MANUFACTURED BY WELL KNOWN NETWORKING COMPANY.
SPECIAL OFFER PRICE £ 57

PLEASE ADD £ 3.00 TO ALL ORDERS TO COVER POSTAGE

NEXT MONTH

FREE CRICKLEWOOD ELECTRONICS 1992 CATALOGUE WORTH £2



MICRO-SENSE ALARM

Thanks to modern technology electronic goods keep becoming smaller and more portable, unfortunately this also makes life easier for the thief. This alarm was designed to protect computers and their peripherals from being removed while unattended.

Items are protected by fixing piezo transducers to them, with self adhesive foam pads. When an attempt is made to remove the sensor a voltage is produced by the piezo crystal as it is distorted, which will set off the alarm. If the security loop is cut or short circuited the alarm will also be set off, tilt switches (and other types of switches) may be connected in series and parallel with the loop and fixed to the back of the sensors for even more security.

STEPPING MOTOR DRIVER/INTERFACE

A single board stand-alone stepping motor driver with built-in oscillator for variable low speed, high speed and acceleration control. A computer connector is included on the p.c.b. The article also explains the basic operation of stepping motors.

CHRISTMAS FUN SPECIAL

An unusual wordsearch puzzle plus a crossword with an electronic theme. To keep you occupied over the festive season.

EVERYDAY ELECTRONICS

JANUARY ISSUE ON SALE FRIDAY DECEMBER 6

VIEWCOM

TEL 081 471 9338 TLX 929709 VICOM G. FAX 081 552 0946
DIGITAL INTEGRATED CIRCUIT SPECIALISTS

4000 SERIES

4000B	0.10
4000UB	0.11
4001A	0.11
4001B	0.10
4001UB	0.12
4002B	0.11
4006B	0.30
4007UB	0.11
4008B	0.31
4009AE	0.16
4009UB	0.18
4010B	0.18
4011B	0.11
4011UB	0.12
4012B	0.11
4013B	0.17
4014B	0.28
4015B	0.31
4016B	0.16
4017B	0.25
4018B	0.26
4019B	0.24
4020B	0.29
4021B	0.32
4022B	0.32
4023B	0.11
4023UB	0.17
4024B	0.21
4025B	0.11
4026B	0.57
4027B	0.16
4028B	0.25
4029B	0.30
4030B	0.15
4031B	0.85
4032B	0.48
4033B	0.56
4034B	0.72
4035B	0.38
4036B	1.75
4038B	0.42
4039B	1.75
4040B	0.26
4041B	0.32
4042B	0.26
4043B	0.32
4044B	0.32
4045B	0.68
4046B	0.38
4047B	0.41
4048B	0.23
4049B	0.16
4049UB	0.17
4050B	0.18
4051B	0.34
4052B	0.31
4053B	0.31
4054B	0.49
4055B	0.48
4056B	0.48
4059B	3.43
4060B	0.36
4063B	0.44
4066B	0.16
4067B	1.15
4068B	0.11
4069UB	0.12
4070B	0.11
4071B	0.11
4072B	0.11
4073B	0.11
4075B	0.11
4076B	0.38
4077B	0.11
4078B	0.11
4081B	0.10
4082B	0.11
4085B	0.32
4086B	0.29
4089B	0.71
4093B	0.16
4094B	0.40
4095B	0.54
4096B	0.85
4097B	1.22
4098B	0.46
4099B	0.38
4104B	0.74
4106B	0.58
4160B	0.65
4161B	0.65
4163B	0.98
4174B	0.98
4175B	0.88
4194B	1.10
4410P	12.65
4411P	16.40
4412FP	27.90
4412VP	12.60
4416L	10.74
4416P	8.45
4419P	4.20
4429PB	5.60
4433P	11.95
4443P	11.95
4447P1	6.20
4467P1	4.64
4469P	22.10
4490P	5.60
4493P	6.82
4494P	4.96
4495P	4.82
4499P	5.96
4500B	8.36
4501UB	0.23
4502B	0.32
4503B	0.42
4504B	1.37
4505B	3.40
4506UB	0.88
4508B	0.72
4510B	0.29
4511B	0.48
4512B	0.35
4513B	2.60
4514B	0.84
4515B	0.68
4516B	0.33
4517B	0.96
4518B	0.38
4519B	0.28
4520B	0.34
4521B	0.82
4522B	0.72
4526B	0.46
4527B	0.46
4528B	0.46
4529B	0.62
4530B	1.48
4531B	0.88
4532B	0.76
4534B	3.98
4536B	1.98
4538B	0.57
4539B	0.62
4541B	0.84
4543B	0.62
4544B	1.48
4547B	1.78
4549B	4.24
4551B	1.08
4553B	1.82
4554B	4.62
4555B	0.36
4556B	0.44
4557B	1.98
4558B	1.68
4560B	1.52
4561B	1.80
4562B	3.96
4566B	2.52
4568B	3.98
4569B	2.34
4572B	0.30
4572UB	0.94
4580B	6.80
4581B	2.96
4582B	1.68
4583B	0.57
4584B	0.44
4585B	0.68
4597B	4.40
4598B	4.40
4599B	3.42
4720B	9.90
4720V	8.87
4723B	2.98
4724B	1.30
4731VP	9.95
4737VP	23.20
4738VP	24.60
4752VP	37.95
4753VP	11.05
4754VP	18.12
40085	0.62
40097	0.45
40098	0.48
40100	1.14
40101	0.76
40102	0.92
40103	0.92
40105	1.88
40106	0.46
40107	0.46
40109	1.44
40110	1.20
40114	1.48
40116	8.10
40117	1.66
40147	1.66
40160	0.52
40161	0.52
40162	0.52
40163	0.52
40174	0.54
40175	0.54
40192	0.62
40193	0.62
40195	0.78
40240	1.36
40244	1.36
40245	1.36
40257	1.48
40373	1.40
40374	1.40
45000P	11.50
45026	4.20
45027	5.76
45028	4.08
45040	7.44
45041	8.94
45106	9.20
45109	3.08
45138	1.48
45151	15.00
45152	16.50
45156	13.50
45157	11.06
45158	11.94
45159	18.90
45406	2.10
45407	4.98
45411	13.20
45428	18.72
45440	14.65
14411P	16.40
14412VP	12.60
14412FP	27.90
14490P	5.60
14494P	4.96
14495P	4.28
14499P	5.96
14500B	8.36

74LS SERIES

74LS00	0.10
74LS01	0.10
74LS02	0.10
74LS03	0.10
74LS04	0.10
74LS05	0.10
74LS06	0.39
74LS07	0.39
74LS08	0.10
74LS09	0.12
74LS10	0.10
74LS11	0.10
74LS12	0.10
74LS13	0.18
74LS14	0.22
74LS15	0.12
74LS20	0.12
74LS21	0.12
74LS22	0.12
74LS24	0.33
74LS26	0.12
74LS27	0.12
74LS28	0.12
74LS30	0.12
74LS32	0.13
74LS33	0.13
74LS37	0.14
74LS38	0.13
74LS40	0.13
74LS42	0.23
74LS47	0.50
74LS48	0.46
74LS49	0.62
74LS51	0.11
74LS54	0.11
74LS55	0.13
74LS73	0.20
74LS73A	0.26
74LS74	0.16
74LS74A	0.18
74LS75	0.21
74LS76	0.22
74LS76A	0.24
74LS77	0.42
74LS78A	0.22
74LS83	0.34
74LS83A	0.37
74LS85	0.34
74LS86	0.22
74LS90	0.24
74LS91	0.74
74LS92	0.29
74LS93	0.24
74LS95	0.38
74LS96	0.46
74LS107	0.25
74LS107A	0.28
74LS109	0.25
74LS109A	0.28
74LS112	0.25
74LS112A	0.27
74LS113	0.44
74LS113A	0.46
74LS114	0.44
74LS114A	0.46
74LS122	0.33
74LS123	0.33
74LS125	0.28
74LS125A	0.30
74LS126	0.28
74LS126A	0.28
74LS132	0.28
74LS133	0.28
74LS136	0.28
74LS137	0.62
74LS138	0.26
74LS139	0.26
74LS145	0.62
74LS147	0.86
74LS148	0.72
74LS151	0.25
74LS153	0.28
74LS154	0.76
74LS155	0.34
74LS156	0.34
74LS157	0.20
74LS158	0.25
74LS160	0.36
74LS160A	0.40
74LS161	0.36
74LS161A	0.40
74LS162A	0.40
74LS163	0.34
74LS163A	0.38
74LS164	0.34
74LS165	0.48
74LS166	0.53
74LS168	0.58
74LS169	0.53
74LS170	0.66
74LS173	0.56
74LS173A	0.60
74LS174	0.28
74LS175	0.30
74LS181	1.48
74LS182	1.58
74LS183	1.58
74LS189A	1.88
74LS190	0.44
74LS191	0.41
74LS192	0.39
74LS193	0.39
74LS194A	0.43
74LS195A	0.42
74LS196	0.43
74LS197	0.40
74LS221	0.43
74LS240	0.43
74LS241	0.40
74LS242	0.41
74LS243	0.48
74LS244	0.38
74LS245	0.38
74LS247	0.38
74LS248	0.38
74LS249	0.68
74LS251	0.22
74LS253	0.34
74LS256	0.50
74LS257	0.30
74LS257A	0.34
74LS258A	0.36
74LS259	0.48
74LS260	0.28
74LS266	0.20
74LS273	0.42
74LS275	6.10
74LS279	0.31
74LS280	0.86
74LS283	0.49
74LS290	0.24
74LS293	0.24
74LS295A	0.64
74LS298	0.63
74LS299	1.18
74LS321	3.77
74LS322A	1.62
74LS323	1.78
74LS347	0.90
74LS348	1.18
74LS352	0.78
74LS353	0.88
74LS363	1.38
74LS364	1.38
74LS365	0.24
74LS365A	0.26
74LS366A	0.32
74LS367	0.26
74LS367A	0.30
74LS368A	1.32
74LS373	0.42
74LS374	0.42
74LS375	0.44
74LS377	0.70
74LS378	0.62
74LS379	0.86
74LS381A	3.05
74LS385	2.22
74LS386	0.46
74LS390	0.39
74LS393	0.34
74LS395	0.66
74LS395A	0.68
74LS398	1.22
74LS399	0.66
74LS461A	4.97
74LS469	4.88
74LS490	0.90
74LS502	2.60
74LS540	0.93
74LS541	0.76
74LS546	4.43
74LS568	1.62
74LS569	1.14
74LS590	4.58
74LS593	4.92
74LS595	3.36
74LS597	3.36
74LS621	1.76
74LS622	1.66
74LS623	1.28
74LS624	2.10
74LS625	2.28
74LS626	2.18
74LS627	2.33
74LS628	2.18
74LS629	0.93
74LS640	0.84
74LS641	0.86
74LS641-1	1.28
74LS642	0.82
74LS642-1	2.48
74LS643	0.84
74LS644	0.84
74LS644-1	2.48
74LS645	0.86
74LS645-1	1.28
74LS646	5.58
74LS651	6.30
74LS652	5.58
74LS668	0.83
74LS669	0.56
74LS670	0.60
74LS673	2.50
74LS674	2.50
74LS682	1.71
74LS683	1.71
74LS684	1.71
74LS685	1.71
74LS686	2.70
74LS687	2.42
74LS688	1.70
74LS689	1.70
74LS693	3.98
74LS794	3.26
74LS795	1.22
74LS796	1.22
74LS797	1.22
74LS848	1.34

74HC SERIES

74HC00	0.13
74HC02	0.13
74HC03	0.13
74HC04	0.15
74HCU04	0.19
74HC05	0.14
74HC08	0.17
74HC10	0.19
74HC11	0.13
74HC14	0.25
74HC14A	0.28
74HC20	0.18
74HC21	0.19
74HC27	0.19
74HC30	0.19
74HC32	0.19
74HC42	0.29
74HC51	0.19
74HC58	0.28
74HC73	0.23
74HC74	0.23
74HC75	0.27
74HC76	0.27
74HC77	0.34
74HC85	0.32
74HC86	0.28
74HC107	0.27
74HC109	0.27
74HC112	0.27
74HC113	0.27
74HC123	0.34
74HC125	0.31
74HC126	0.32
74HC131	0.35
74HC132	0.32
74HC133	0.32
74HC137	0.51
74HC138	0.32
74HC139	0.21
74HC141	0.41
74HC147	0.41
74HC148	0.37
74HC151	0.31
74HC153	0.31
74HC154	0.89
74HC155	0.47
74HC157	0.33
74HC158	0.33
74HC160	0.43
74HC161	0.43
74HC162	0.43
74HC163	0.43
74HC164	0.43
74HC165	0.55
74HC166	0.59
74HC173	0.51
74HC174	0.37
74HC175	0.37
74HC181	1.30
74HC182	0.40
74HC190	0.80
74HC191	0.54
74HC192	0.52
74HC193	0.40
74HC194	0.45
74HC195	0.45
74HC221	0.62
74HC237	0.49
74HC238	0.50
74HC240	0.47
74HC241	0.46
74HC242	0.54
74HC243	0.59
74HC244	0.43
74HC245	0.47
74HC251	0.24
74HC253	0.35
74HC257	0.39
74HC258	0.49
74HC259	0.51
74HC266	0.44
74HC273	0.41
74HC279	0.34
74HC280	0.60
74HC283	0.60
74HC298	0.49
74HC299	1.04
74HC323	1.07
74HC354	0.37
74HC356	0.44
74HC365	0.33
74HC366	0.35
74HC367	0.35
74HC368	0.35
74HC373	0.45
74HC374	0.47
74HC375	0.51
74HC377	0.51
74HC386	0.19
74HC390	0.49
74HC393	0.46
74HC423	0.64
74HC521	0.64
74HC533	0.64
74HC534	0.60
74HC540	0.69
74HC541	0.69
74HC563	0.59
74HC564	0.59
74HC573	0.64
74HC573A	0.68
74HC574	0.64
74HC589	1.10
74HC590	0.80
74HC592	0.80
74HC593	1.12
74HC595	0.84
74HC597	0.79
74HC620	1.09
74HC623	1.09
74HC633	1.09
74HC640	0.89
74HC643	0.89
74HC645	0.94
74HC646	1.19
74HC648	1.19
74HC651	0.99
74HC652	0.99
74HC658	3.02
74HC659	3.02
74HC664	3.02
74HC665	3.02
74HC670	0.74
74HC677	2.55
74HC678	3.98
74HC680	2.58
74HC682	4.64
74HC684	2.54
74HC688	0.79
74HC690	1.09
74HC691	1.09
74HC692	1.16
74HC693	1.16
74HC696	1.06
74HC697	1.06
74HC698	1.06
74HC699	1.06
74HC4002	0.24
74HC4015	0.72
74HC4016	0.49
74HC4017	0.30
74HC4020	0.49
74HC4022	0.38
74HC4024	0.33
74HC4028	0.39
74HC4040	0.33
74HC4046	1.30
74HC4049	0.37
74HC4050	0.37
74HC4051	0.68
74HC4052A	0.74
74HC4053	0.74
74HC4053A	0.74
74HC4060	0.32
74HC4061	1.70
74HC4066	0.32
74HC4066A	0.36
74HC4072	0.30
74HC4075	0.25
74HC4078	0.31
74HC4094	0.49
74HC4511	0.69
74HC4514	1.19
74HC4515	1.19
74HC4518	0.54
74HC4520	0.59
74HC4538	0.74
74HC4543	0.74
74HC7001	0.68
74HC7002	0.68
74HC7006	1.34
74HC7008	1.88
74HC7032	0.68
74HC7074	1.34
74HC7075	1.34
74HC7076	2.04
74HC7266	0.56
74HC7292	0.77
74HC7294	0.77
74HC40102	0.84
74HC40103	0.84
74HC40105	1.40

74HCT SERIES

74HCT00	0.22
74HCT02	0.22
74HCT03	0.22
74HCT04	0.22
74HCT08	0.22
74HCT10	0.22
74HCT11	0.22
74HCT14	0.26
74HCT20	0.26
74HCT21	0.26
74HCT27	0.22
74HCT30	0.22
74HCT32	0.22
74HCT42	0.46
74HCT73	0.36
74HCT74	0.26
74HCT75	0.36
74HCT85	0.60
74HCT86	0.36
74HCT93	0.58
74HCT107	0.40
74HCT109	0.42
74HCT112	0.42
74HCT123	0.64
74HCT125	0.56
74HCT126	0.56
74HCT132	0.50
74HCT137	0.52
74HCT138	0.34
74HCT139	0.45
74HCT147	0.54
74HCT151	0.52
74HCT153	0.44
74HCT154	1.18
74HCT157	0.44
74HCT158	0.44
74HCT160	0.56
74HCT161	0.56
74HCT162	0.56
74HCT163	0.56
74HCT164	0.52
74HCT165	0.52
74HCT166	0.52
74HCT173	0.52
74HCT174	0.52
74HCT175	0.52
74HCT181	2.48
74HCT182	0.96
74HCT190	0.64
74HCT191	0.64
74HCT192	0.64
74HCT193	0.64
74HCT194	0.76
74HCT195	0.78
74HCT221	0.98
74HCT237	0.94
74HCT238	0.88
74HCT240	0.62
74HCT241	0.62
74HCT242	0.76
74HCT243	0.64
74HCT244	0.62
74HCT245	0.62
74HCT251	0.58
74HCT253	0.34
74HCT257	0.48
74HCT258	0.48
74HCT259	0.78
74HCT273	0.68
74HCT280	0.98
74HCT283	0.96
74HCT299	1.64
74HCT354	0.86
74HCT356	0.86
74HCT365	0.54
74HCT366	0.54
74HCT367	0.54
74HCT368	0.54
74HCT373	0.58
74HCT374	0.58
74HCT377	0.64
74HCT390	0.68
74HCT393	0.68
74HCT521	0.98
74HCT521A	1.10
74HCT533	0.68
74HCT534	0.64
74HCT540	0.64
74HCT541	0.64
74HCT563	0.66
74HCT564	0.66
74HCT573	0.64
74HCT574	0.64
74HCT583	1.26
74HCT640	0.90
74HCT643	0.90
74HCT645	0.75
74HCT646	1.28
74HCT648	1.28
74HCT651	1.10
74HCT652	1.10
74HCT670	1.10
74HCT673	1.10
74HCT688	1.10
74HCT4002	0.26
74HCT4015	0.76
74HCT4016	0.52
74HCT4017	0.68
74HCT4020	0.74
74HCT4024	0.68
74HCT4040	0.70
74HCT4046	1.60
74HCT4046A	2.10
74HCT4051	0.84
74HCT4052	0.84
74HCT4053	0.84
74HCT4060	0.84
74HCT4066	0.66
74HCT4067	3.32
74HCT4075	0.36
74HCT4094	0.84
74HCT4316	0.68
74HCT4351	1.04
74HCT4510	1.04
74HCT4511	0.94
74HCT4514	1.64
74HCT4515	1.68
74HCT4516	1.08
74HCT4520	0.90
74HCT4538	1.02
74HCT7007	0.26
74HCT7046A	2.80
74HCT40102	1.64
74HCT40103	1.48
74HCT40104	1.82
74HCT40105	1.40

We also stock other 74 & 4000 Series including Surface Mount.

TRANSISTORS THYRISTORS & TRIACS

2N2219A	0.28
2N2222	0.28
2N2222A	0.22
2N2243	0.78
2N2369	0.24
2N2369A	0.24
2N2484	0.32
2N2894	0.78
2N2905	0.32
2N2905A	0.32
2N2907	0.30
2N2907A	0.30
2N2923	0.30
2N3053	0.34
2N3055	0.68
2N3441	1.20
2N3553	0.98
2N3684	1.68
2N3702	0.10
2N3704	0.10
2N3706	0.10
2N3725	0.78
2N3789	2.16
2N3819	0.54
2N3866	1.24
2N3904	0.11
2N3905	0.12
2N3906	0.10
2N3958	2.12
2N4037	0.48
2N405	2.30
2N4062	0.32
2N4091	0.78
2N4123	0.10
2N4124	0.20
2N4125	0.18
2N4126	0.32
2N4221A	2.96
2N4236	3.72
2N4401	0.18
2N4403	0.18
2N4921	1.40
2N5401	0.16
2N5415	0.72
2N5449	0.88
2N5459	0.53
2N5485	0.48
2N5876	1.32
2N6034	0.72
2N6037	0.72
2N6050	3.12
2N6051	3.49
2N6054	2.20
2N6056	1.94
2N6057	2.24
2N6058	2.68
2N6109	0.78
2N6125	2.88
2N6388	0.98
2N6517	0.34
2N6519	0.34
2N6668	1.40
2N696	0.26
2N706A	0.48
2SK129A	5.24
2SK246Y	0.30
3SK45	1.85
3SK88	0.84
40406	1.60
40673	2.40
BC140-16	0.48
BC146/01	0.58
BC149	0.40
BC157	0.34
BC158	0.34
BC169C	0.14
BC179	0.34
BC182	0.05
BC182A	0.06
BC182B	0.06
BC182L	0.06
BC182LB	0.07
BC183	0.07
BC183C	0.07
BC183L	0.07
BC184	0.07
BC184B	0.07
BC184L	0.07
BC184LC	0.08
BC212-18	0.08
BC212A	0.07
BC212B	0.07
BC212L	0.07
BC212LB	0.08
BC213	0.07
BC213L	0.07
BC214	0.07
BC214L	0.10
BC237	0.08
BC307	0.08
BC327	0.07
BC328	0.07
BC337	0.07
BC337-25	0.08
BC489	0.24
BC490	0.30
BC516	0.22
BC517	0.20
BC546	0.05
BC546A	0.05
BC546B	0.05
BC547	0.07
BC547A	0.07
BC547B	0.07
BC547C	0.07
BC548	0.07
BC548B	0.07
BC549	0.07
BC549B	0.07
BC550	0.08
BC550B	0.07
BC550C	0.08
BC556	0.05
BC556A	0.05
BC556B	0.05
BC557	0.07
BC557B	0.07
BC558	0.07
BC558A	0.07
BC558B	0.07
BC559A	0.07
BC559B	0.07
BC560A	0.07
BC560C	0.07
BC184C	0.07
BCY71	0.30
BD131	0.52
BD135	0.42
BD241A	0.98
BD242C	0.52
BD243	0.50
BD516	0.78
BD675	0.52
BD676	0.52
BD679	0.54
BD680	0.56
BD743C	1.90
BDT85	1.12
BDX67B	2.78
BDY96	3.60
BF195-C	0.07
BF199	0.22
BF200	0.16
BF256B	0.38
BF256C	0.38
BF259	0.40
BF324	0.28
BF421	0.12
BF450	0.20
BF451	0.22
BF494	0.16
BF759	0.26
BF961	0.66
BF981	0.90
BF982	0.88
BFG65	1.79
BFR91	0.62
BFW10	1.20
BFX48	0.49
BFX85	0.59
BFX88	0.30
BFX89	1.59
BFY50	0.34
BFY52	0.34
BFY90	0.92
BS107	0.26
BS170	0.46
BS250	0.52
BSR60	0.48
BSX20	0.38
BSX21	0.48
BSX61	1.85
BT136-600	1.10
BUW46	3.10
BUZ11	1.60
BUZ11A	1.62
BUZ47A	6.90
IRFZ14	1.14
IRFZ20	1.77
J113	0.39
J175	0.68
J270	0.92
JA101	0.48
MBD501	1.10
MJE13070	1.10
MJE340	0.68
MJE350	1.10
MJE520	0.80
MPS3638	0.18
MPSA06	0.12
MPSA13	0.12
MPSA63	0.32
MPSA92	0.24
MPSU05	2.21
MTP8P08	2.80
OC147	1.80
OC19	1.85
OC45	0.65
OC72	0.80
OC78	0.80
OC81M	0.80
OC81Z	0.92
PN3643	0.18
TIC106M	0.78
TICP206D	0.61
TICV106D	0.24
TIP115	0.55
TIP121	0.68
TIP145	1.37
TIP2955	1.42
TIP30	0.48
TIP3055	1.28
TIP31	0.44
TIP32A	0.40
TIP47	0.80
V275LA10	0.92
VN0104N3	0.92
VN66AFD	1.40
VN90AB	2.98
VP0104-N3	0.92
VP0104N2	0.98
VP0104N3	0.92
ZTX212	0.18
ZTX237	0.26
ZTX300	0.18
ZTX313L	0.28
ZTX320	0.38
ZTX510	0.18
ZTX550	0.24
ZTX551	0.36
ZVN0109L	0.64

DIODES

1N2986RB	18.20
1N3881	2.54
1N3997A	6.55
1N4001	0.04
1N4002	0.04
1N4003	0.04
1N4006	0.04
1N4007	0.04
1N4148	0.03
1N4149	0.06
1N4150	0.08
1N4446	0.06
1N4728A	0.24
1N4735A	0.24
1N4736A	0.24
1N4740A	0.24
1N4743A	0.24
1N4744A	0.24
1N4756A	0.24
1N5226B	0.09
1N5232B	0.09
1N5234B	0.09
1N5337B	0.48
1N5349B	0.48
1N5352B	0.48
1N5357B	0.48
1N5365B	0.48
1N5366B	0.48
1N5370B	0.48
1N5380B	0.48
1N5401	0.11
1N5402	0.11
1N6287A	1.55
1N825	1.40
1NA825	1.40
1N827	1.40
1SS252	0.20
5082-2800	0.66
5082-2810	1.40
5082-2835	0.44
AA119	0.60
AA144	0.72
AAZ18	0.45
BAV10	0.07
BAV45	2.10
BAW62	0.06
BAX16	0.06
BB204	0.32
BB212	2.48
BB405B	0.22
BB809	2.40
BY179	0.42
BY260-200	3.58
BY261-200	3.98
BYV28-100	0.78
BYV32-50	1.60
CV8805	0.60
DS16C	0.40
MV1404	15.90
MV209	1.20
OA200	0.10
OA202	0.20
OA47	0.14
OA90	0.14
OA91	0.16
P6KE36A	0.88
P6KE47A	0.88

ZENER DIODES MISC

BZY93C7V5	2.66
BZY93C15	2.66
BZY93C18R	2.66
BZY93C20	2.66
BZY93C24V	2.66
BZY93C33R	2.66
BZT03C120	0.40
BZX61C9V2	0.09
BZX61C24V	0.09

ZENER DIODES
400mW
2.4V to 75V
Price: **6p each**

ZENER DIODES
500mW
2.4V to 200V
Price: **6p each**

ZENER DIODES
1.3 WATT
2.7V to 200V
Price: **10p each**

ZENER DIODES
3.0 WATT
7.5V to 270V
Price: **40p each**

ZENER DIODES
5.0 WATT
3.3V to 200V
Price: **42p each**

ZENER DIODES
STUD MOUNT
20 WATT
7.5V to 75V
Each **£3.16**

CRYSTALS CAN HC18/U

Freq MHz	
1.843200	1.82
2.000000	1.66
2.457600	1.49
3.276800	0.98
3.579545	1.10
3.686400	1.10
4.000000	1.10
4.096000	1.10
4.194304	1.10
4.433619	1.10
4.608000	1.10
4.915200	1.20
5.000000	1.10
5.068800	1.10
5.242880	1.20
6.000000	1.10
6.144000	1.10
6.400000	1.64
6.553600	1.21
7.372800	0.78
8.000000	1.00
8.867230	1.34
9.830000	1.20
10.00000	1.10
10.69500	1.90
11.00000	1.10
12.00000	1.10
13.87500	2.40
14.00000	1.64
14.31818	0.85
14.74560	1.10
15.00000	1.10
16.00000	1.10
18.43200	1.10
19.66080	1.20
20.00000	1.10
22.11840	1.68
24.00000	1.98
27.64800	1.20
30.00000	6.99
32.00000	1.21
48.00000	1.68
5.888200	1.80

CAN HC33/U

Freq. = MHz	
0.204800	8.23
0.307200	6.99
1.000000	3.95
1.843200	3.71
2.000000	4.65
2.097152	3.71
2.457600	1.92
2.500000	1.92
3.000000	2.25

CAN HC49/U4H

Freq. = MHz	
3.276800	1.66
5.068800	2.25
7.864320	1.49
8.000000	1.14
10.00000	2.25
11.05920	2.80
12.00000	1.14
14.00000	2.25
16.00000	1.14
20.00000	1.52
24.00000	1.90

CAN UM-1

Freq. = MHz	
8.000000	2.25
8.192000	2.02
10.00000	2.25
11.00000	2.25
12.28800	2.66
15.00000	2.25
18.00000	2.50
20.00000	2.25
21.00000	2.25
24.00000	2.80
17.73447	2.80

CRYSTALS MISC.

Freq. = MHz	
0.032768 MINI CYL	0.88
0.032768 WATCH	0.82

IC SOCKETS LOW PROFILE

Pins/Width SOLDER TAIL

6 Pin/0.3	0.06
8 Pin/0.3	0.06
14 Pin/0.3	0.08
16 Pin/0.3	0.10
18 Pin/0.3	0.11
20 Pin/0.3	0.12
22 Pin/0.3	0.14
24 Pin/0.3	0.14
24 Pin/0.6	0.14
28 Pin/0.6	0.16
32 Pin/0.6	0.22
40 Pin/0.6	0.22

TURNED PIN GOLD

6 Pin/0.3	0.18
8 Pin/0.3	0.18
14 Pin/0.3	0.31
16 Pin/0.3	0.33
18 Pin/0.3	0.39
20 Pin/0.3	0.45
22 Pin/0.3	0.54
24 Pin/0.3	0.54
24 Pin/0.6	0.54
28 Pin/0.6	0.60
32 Pin/0.6	0.65
40 Pin/0.6	0.70
48 Pin/0.6	0.85
64 Pin/0.75	2.60
64 Pin/0.9	2.60

VOLTAGE REGULATORS

78008AP	1.15
7805	0.30
7805A	0.35
7805FA	0.45
7806	0.30
7808	0.30
7809	0.35
7812	0.30
7812A	0.40
7815	0.30
7818	0.30
7824	0.30
78L05	0.26
78L05A	0.30
78L12	0.26
78L12A	0.30
78L15	0.26
78L24	0.26
78L56	1.10
78M05	0.40
78M05A	0.40
78M12	0.40
78M12A	0.40
78M13A	0.65
78M15	0.40
7905	0.30
7905A	0.40
7905FA	0.60
7909	0.55
7912	0.30
7912A	0.50
7912FA	0.72
7915	0.30
7918	0.30
7924	0.30
79L12A	0.45
79M05	0.65
79M05A	0.85
79M05FA	0.85
79M12	0.85
79M12A	0.90
LM317K	2.10
LM317T	0.84
LM320K-12	5.80
LM320T-5.0	2.38
LM320T-12	2.38
LM320T-15	2.38
LM340T-5.0	0.40
LM340T-12	0.40
LM340T-15	0.40

LINEAR & MISC

3630BM	3.40
3660K	3.70
4N33	0.60
5541BJG	2.60
555	0.20
58174AN	11.88
6N136	1.60
6N139	1.75
93L34DC	6.64
96L02PC	3.40
AD202JY	42.98
AD204JY	33.45
AD232JN	4.55
AD233JN	5.43
AD235JN	8.16
AD238JN	4.72
AD246JY	15.74
AD524AD	16.30
AD536AJD	25.75
AD548JN	1.53
AD558JN	20.96
AD574JD	24.20
AD581JH	5.40
AD585AQ	23.64
AD590KH	9.92
AD592CN	14.68
AD594AD	2.68
AD595AD	4.64
AD595AQ	10.89
AD625JN	9.52
AD648JN	2.41
AD654JN	7.61
AD705JN	1.75
AD707JN	2.34
AD708JN	5.45
AD711JN	1.88
AD712JN	2.51
AD713JN	9.83
AD7245JN	19.87
AD7248JN	19.87
AD736JN	9.79
AD741KN	0.82
AD7523JN	4.07
AD7523KN	6.80
AD7537JN	21.69
AD7541JN	11.69
AD7542KN	11.98
AD7547JN	24.17
AD7569JN	12.20
AD7576JN	9.68
AD7578KN	35.89
AD7580JN	18.01
AD7821KN	18.04
AD7828KN	21.86
AD7840JN	21.01
AD7845JN	15.91
AD790JN	11.00
AD827JN	14.91
AD844AN	8.75
AD847JN	6.94
AD848JN	6.94
AD849JN	6.94
AD9696KN	13.06
AD9698KN	22.40
ADC0801LCN	27.10
ADC0832CCN	6.26
ADC0834CCN	6.87
ADC0838CCN	11.04
ADC08238CCN	9.35
ADC0803LCN	13.30
ADC0841CCN	7.54
ADC0804LCN	7.08
ADC0804LCWM	7.54
ADC0809CCN	9.87
ADC0817CCN	23.96
ADC0819CCV	6.81
ADC0844CCN	12.69
ADC1031C1N	17.28
ADC1038C1N	18.49
ADC84KG-10	12.60
ADC908HP	8.90
ADC912HP	18.30
ADD3501CCN	23.67
ADG201AKN	3.60
ADG201HSJN	10.75
ADOP07CN	1.60
AH0015CD	17.20
AM26L02PC	1.91
AM26LS31CN	1.38
AM26LS31PC	1.38
AM26LS32ACN	1.65
AM26LS33ACN	2.94
AM2966PC	2.48
AM29826DC	3.22
AM8238PC	3.80
AM9102CPC	1.85
AM9114BDM-B	2.20
AM9551PC	9.98
AY-3-1270	3.60
AY-5-1013	3.20
AY-5-1013A	5.24
AY-5-8136	6.45
BA6109	1.68
BA6208	1.40
BA6251	2.80
BAA1505	1.80
CA1458E	0.39
CA1458P	0.52
CA3028A	1.78
CA3045	6.30
CA3046	0.76
CA3053	1.57
CA3054	0.94
CA3059	1.20
CA3078AT	2.42
CA3079	0.88
CA3080E	0.70
CA3081	0.96
CA3082	1.32
CA3083	1.32
CA3086	0.60
CA3089E	1.10
CA3094AE	2.01
CA3096AE	2.16
CA3097E	2.45
CA3100E	1.59
CA311E	0.30
CA3127E	2.62
CA3130BT	13.20
CA3130E	1.10

CA3140E	0.87
CA3141E	1.42
CA3146E	1.16
CA3160E	1.25
CA3161E	1.41
CA3162E	5.29
CA3183E	1.39
CA3189E	1.30
CA3240E	1.38
CA324E	0.44
CA3260E	1.68
CA3290E	0.91
CA3306CE	9.23
CA339E	0.33
CA3420E	1.57
CA358E	0.33
CA555CE	0.20
CA741CE	0.18
CD82C55A	8.85
CNX36	0.40
CS8205	0.98
DAC08EP	2.78
DAC08CP	2.60
DAC0800LCN	3.60
DAC0806LCN	3.10
DAC0830LCN	12.26
DAC0832LCN	7.13
DAC1000LCN	19.99
DAC1006LCN	19.99
DAC1008LCN	11.85
DAC1020LCN	18.67
DAC1201KPV	14.36
DG200CJ	4.16
DG201ABK	4.37
DG201ACJ	3.73
DG201CJ	5.70
DG211	2.05
DG212CJ	2.25
DG303ACJ	6.85
DG508CJ	4.45
DG509ACJ	6.30
DP8212N	2.56
DP8304BN	2.40
DS1221	6.44
DS1228	3.90
DS1231	4.44
DS1231-20	4.44
DS1232	3.78
DS1488N	0.30
DS1489AN	0.30
DS1489N	0.30
DS14C88M	1.60
DS14C88N	1.25
DS14C89AN	1.25
DS14C89N	1.56
DS3486N	1.92
DS3487N	1.92
DS34C86N	2.80
DS34C87N	2.80
DS75150N	1.21
DS75154N	1.21
DS75160AN	5.66
DS75161AN	6.14
DS75176BN	1.62
DS75361N	2.51
DS75451N	0.62
DS75452N	0.62
DS75453N	0.62
DS75491N	0.85
DS75492N	1.09
DS75494	2.38
DS8640N	0.98
DS8641N	2.06
DS8836N	1.05
DS8837N	2.10
DS8838N	2.10
DS88C20N	5.72
HA12017	1.44
HA13426	11.96
HCPL-2231	10.28
HCPL-2602	6.89
HCPL-2630	4.80
HCPL-2730	3.90
HCPL-2731	3.80
HCPL-4200	6.15
HCPL-2200	6.38
HEF4754VP	12.40
HI1-0201-5	3.30
HI1-0506-5	12.19
HI1-0507-5	12.19
HI1-0509-5	6.84
HI1-0509A-5	9.79
HI3-0201-5	3.40
HS574AK	19.90
ICL232CPE	4.93
ICL232CPE	4.93
ICL7106CPL	6.75
ICL7107CPL	6.95
ICL7109CPL	6.60
ICL7116CPL	5.25
ICL7126CPL	5.35
ICL7135CN	11.53
ICL7135CPI	8.32
ICL7606CJN	17.02
ICL7611DCBA	2.00
ICL7611DCPA	1.32
ICL7611SBCPA	3.05
ICL7612DCPA	1.71
ICL7621BCPA	5.79
ICL7621DCBA	2.58
ICL7621DCPA	1.98
ICL7642ECPD	3.24
ICL7650SCPD	4.48
ICL7652BCPD	5.82
ICL7652SCPD	7.29
ICL7660CBA	3.11
ICL7660CPA	1.40
ICL7660SCPA	2.74
ICL7662CPA	3.24
ICL7663BCJA	3.12
ICL7663BCPA	3.12
ICL7663SCPA	3.63
ICL7664CPA	3.95
ICL7665BCPA	4.42
ICL7665SACPA	4.73
ICL7667CPA	2.66
ICL766OCPA	2.74
ICL7673CPA	1.60
ICL8038CCPD	4.70
ICL8052ACPD	12.85
ICL8068ACJD	13.40
ICL8069CCSQ	2.59
ICL8069DCSQ	2.68
ICL8069DCZR	1.61

ICL8211CPA	2.28
ICL8212CPA	1.10
ICM7170IPG	7.66
ICM7207AIPD	6.80
ICM7207IPD	5.76
ICM7211AIPL	4.98
ICM7211AMIPL	4.98
ICM7212AMIPL	4.60
ICM7216AIJI	27.72
ICM7217AIPI	9.85
ICM7217BIJI	10.42
ICM7217IJI	10.42
ICM7218AIJI	8.41
ICM7218CIJI	8.41
ICM7218DIJI	8.41
ICM7218EIJL	16.88
ICM7224IPL	9.24
ICM7226BIPL	25.04
ICM7227AIPI	12.60
ICM7232CRIPL	7.72
ICM7242IPA	2.40
ICM7249IDM	14.62
ICM7555CBA	1.47
ICM7555IPA	0.64
ICM7556IPD	1.30
ICL7104-16CPL	26.08
ICL7106CPL	6.75
ICL7107CPL	6.95
ICL7109CPL	6.60
ICL7116CPL	5.25
ICL7126CPL	5.35
ICL7606CJN	17.02
ICL7611DCPA	1.32
ICL7621DCPA	1.98
ICL7652BCPD	5.82
ICL7660CPA	1.40
ICL7662CPA	3.24
ICL7673CPA	1.60
ICL8069CCSQ	2.59
ICL8069DCSQ	2.68
ICL8069DCZR	1.61
ICL8211CPA	2.28
ICL8212CPA	1.10
ICM7170IPG	7.66
ICM7207IPD	5.76
ICM7211AIPL	4.98
ICM7211AMIPL	4.98
ICM7212AMIPL	4.60
ICM7216AIJI	27.72
ICM7217AIPI	9.85
ICM7217IJI	10.42
ICM7218AIJI	6.85
ICM7218CIJI	6.85
ICM7218DIJI	6.85
ICM7218EIJL	15.90
ICM7224IPL	9.24
ICM7226BIPL	25.04
ICM7227AIPI	12.60
ICM7555IPA	0.64
ICM7556IPD	1.30
ILD74	0.99
INA101HP	9.65
INS8250N	13.38
ISO102	7.60
ISQ74	0.99
L272	2.83
L293B	3.48
L293E	4.56
L297	5.31
L297A	4.69
L298N	8.31
L4805CV	2.20
L4810CN	2.40
L487	3.15
L4960	3.54
L702B	2.52
L723	0.79
L7808CV	0.50
LF13201N	7.80
LF13202N	7.80
LF13333N	7.80
LF13508D	18.20
LF155H	10.86
LF156H	9.62
LF157H	9.62
LF256H	7.21
LF311H	7.92
LF347BN	6.74
LF347N	0.88
LF351M	0.66
LF351N	0.43
LF353N	0.45
LF355H	3.05
LF355N	1.08
LF356BN	3.36
LF356H	3.05
LF356M	2.39
LF356N	1.40
LF357BN	0.90
LF357DP	1.75
LF357N	1.60
LF398D	3.71
LF398H	7.05
LF398N	2.75
LF411CN	1.20
LF412ACN	10.11
LF412CN	1.20
LF441ACN	6.93
LF441CN	0.90
LF442CN	1.40
LF444CN	2.80
LH0002CH	21.17
LH0002CN	10.80
LH0021CK	43.68
LH0022CH	18.20
LH0024CH	39.26
LH0032CG	42.25
LH0041CJ	31.17
LH0042CH	12.52
LH0062CH	37.57
LH2311D	21.17
LIU01FP	9.94
LM101AH	4.43
LM101AJ	5.84
LM105H	9.48
LM107H	4.43
LM108AH	22.49
LM108ALB	7.38
LM108H	12.30
LM10CH	11.09
LM10CLH	8.40
LM10CLN	5.75
LM10CN	9.24
LM110H	8.76

LM111H	6.74
LM117H	20.70
LM118H	20.28
LM119H	17.05
LM119J	22.93
LM124AJ	24.99
LM124J	3.83
LM12CLK	29.25
LM131H	20.14
LM134H	10.81
LM135H	12.03
LM13600N	2.44
LM13700N	2.32
LM139AJ	18.30
LM139J	3.31
LM1458H	2.89
LM1458M	1.05
LM1458N	0.45
LM148J	10.18
LM1496N	2.39
LM1558H	5.75
LM1558J	5.75
LM1578H	20.43
LM158AH	14.99
LM158H	6.88
LM161H	14.33
LM1801N	3.42
LM1877N-9	7.13
LM1881N	3.80
LM1886N	4.39
LM1894N	4.16
LM193AH	18.67
LM193H	11.51
LM1946N	3.35
LM201AH	4.81
LM207H	4.17
LM208AH	16.17
LM208H	8.75
LM211H	5.84
LM218H	15.75
LM224J	3.54
LM224N	2.01
LM231N	9.01
LM239J	4.23
LM239N	1.28
LM248J	7.72
LM2575T-12	6.26
LM2575T-15	6.26
LM2575T-5.0	6.26
LM2575T-ADJ	7.16
LM2577T-12	7.07
LM2577T-15	7.07
LM2577T-ADJ	7.76
LM2578H	8.28
LM2578N	3.97
LM2579T	12.91
LM2901N	1.16
LM2902N	0.60
LM2903N	0.60
LM2904N	0.60
LM2907N	5.41
LM2917N	5.20
LM2917N-8	3.65
LM2925T	4.33
LM2940CT-5.0	1.20
LM2941CT	3.40
LM2984CT	3.84
LM301AN	0.40
LM3046N	2.69
LM305AH	6.39
LM305H	2.39
LM307N	0.60
LM3080N	2.03
LM3086N	1.59
LM308A	2.03
LM308AH	7.54
LM308AN	2.50
LM308H	2.70
LM308N	1.01
LM310H	4.81
LM310N	2.39
LM311H	2.22
LM311J-8	3.76
LM311N	0.40
LM311N-14	2.15
LM311P	0.77
LM312H	4.98
LM317H	9.23
LM317KC	5.05
LM317LZ	1.16
LM317MP	1.75
LM317T	0.84
LM318H	3.84
LM318J-8	6.28
LM318N	1.25
LM318P	1.25
LM319H	6.28
LM319J	7.32
LM319N	1.45
LM324AN	2.82
LM324J	1.60
LM324N	0.35
LM325N	4.60
LM3302N	1.64
LM331AN	11.66
LM331N	7.56
LM334Z	1.46
LM335Z	2.16
LM3361AN	3.32
LM336Z-2.5	1.28
LM336Z-5.0	1.20
LM337J	3.28
LM338K	6.50
LM338K STEEL	7.98
LM339AN	1.00
LM339J	2.44
LM339N	0.36
LM340AT-12	1.68
LM343H	7.83
LM346N	3.10
LM348DP	0.48
LM348J	3.34
LM348N	0.48
LM34DZ	4.34
LM350K/STEEL	11.50
LM350T	2.68
LM3524N	1.71
LM3578N	3.06
LM358AN	2.93
LM358N	0.32
LM358P	0.77
LM359N	3.44
LM35CHN	10.58
LM35CZ	7.54

LM35DH	5.63
LM35DZ	4.34
LM360H	7.72
LM360N	9.83
LM361N	5.66
LM363H-100	4.65
LM376N	1.35
LM377N	3.53
LM380N	1.00
LM380N-14	2.12
LM380N-8	2.10
LM381AN	5.65
LM381N	4.53
LM383T	4.34
LM384N	4.17
LM385LP-1.2	2.06
LM385LP-2.5	2.06
LM385M-1.2	2.40
LM386M-1/SMD	1.65
LM386N	1.72
LM386N-1	1.63
LM386N-4	2.16
LM387AN	3.27
LM387N	3.15
LM388N-1	2.46
LM3900N	0.72
LM3909N	2.16
LM3911N	3.15
LM3914N	3.68
LM3915N	6.28
LM3916N	4.10
LM392N	1.56
LM393AN	1.42
LM393N	0.40
LM393P	0.70
LM394CH	6.47
LM394CN	4.96
LM394H	10.35
LM3999Z	2.77
LM399H	6.38
LM4250CN	2.22
LM4250J	6.35
LM431ACZ	0.99
LM555CM	0.40
LM555CN	0.28
LM556CN	1.16
LM556J	8.35
LM567CN	1.35
LM604CN	4.16
LM607CN	2.96
LM611CN	2.67
LM6125H	14.99
LM613N	2.68
LM614CN	4.03
LM6213N	6.95
LM6218N	10.04
LM621N	9.34
LM6221N	7.98
LM6225N	9.55
LM6264J	17.20
LM6265N	8.38
LM6361N	2.90
LM6364N	2.95
LM675T	7.67
LM709CH	2.70
LM709CN	1.85
LM710CH	1.68
LM710CN	1.64
LM710H	4.59
LM715CH	6.29
LM723CH	1.62
LM723CN	0.85
LM723H	6.90
LM725CH	12.52
LM725CN	9.39
LM733CH	2.93
LM733CN	1.93
LM741CH	1.56
LM741CN	0.28
LM741EN	2.29
LM741H	4.40
LM741J	3.96
LM747CN	0.56
LM747J	4.59
LM748CH	2.29
LM748CN	1.13
LM759CH	4.78
LM759CP	3.75
LM77000CP	2.98
LM776CN	2.51
LM78GCP	1.52
LM78L05ACZ	0.30
LM78MGCP	1.57
LM7912CT	0.38
LM7915CT	0.40
LM833N	2.10
LM837N	2.72
LMC555CN	1.04
LMC660CN	1.79
LMD18200T	20.29
LMD18201T	18.96
LMF40C1N-100	5.41
LMF40C1N-50	5.41
LMF60C1N-100	8.17
LMF60C1N-50	8.45
LP2951ACN	4.53
LP311N	1.38
LP324N	1.38
LP339N	1.23
LP365N	1.26
LPC6621N	2.29
LS204CB	1.34
LS285AB	3.55
LS288B	3.60
LS404CB	2.36
LT1004CLP-1.2	2.79
LT1004CLP-2.5	2.79
LT1006CN8	2.68
LT1007CP	4.07
LT1009CP	2.79
LT1014	9.80
LT1030CN	3.28
LT1032CN	4.20
LT1037CP	4.07
LT1052CPK	3.71
LT1054	6.86
LT1070CKV	13.08
LT1071CKV	10.54
LT1083CP	8.15
LT1084CKK	10.54
LTC485CN8	1.92
M5218P	0.44
M5220	0.70
M54547P	1.90

M706B1	1.42
MAX232CPE	3.90
MAX232EWE/SMD	6.86
MAX359CPE	6.80
MAX452CPA	5.38
MC10103P	1.24
MC1350P	3.10
MC1377P	4.93
MC1413P	0.74
MC14490P	3.40
MC145406P	2.63
MC1455P	0.40
MC1458P	0.32
MC1488L	1.46
MC1488P	0.58
MC1489A	0.80
MC1489P	0.46
MC1558L	2.80
MC3301P	0.88
MC3302P	0.68
MC3479P	7.92
MC3486N	2.45
MC3523U	2.94
MC4024P	6.64
MC4044P	6.35
MCT2	0.84
MCT61	1.18
MM53200N	2.98
MM58167AN	13.32
MM58174AN	14.52
MM58274BN	6.30
MM58274CN	6.30
MPOP07CP	2.02
MUX08-EP	6.52
MV601DP	3.31
N8264N	3.68
NE5020N	8.24
NE5532N	0.72
NE5534P	1.19
NE555N	0.20
NE556D	0.88
NE556N	0.40
NE565N	1.16
NE566N	1.14
NE567N	0.65
NE568N	3.85
NE570N	2.75
NE589N	3.25
NE592N14	0.92
NJM4556D	0.86
NJM4556S	0.86
NJM4558DX	0.86
NJM4558S	0.60
NS16450N	10.42
OP07-CP	2.35
OP11-GP	4.26
OP227-GY	10.04
OP27-GP	2.89
PBD352302	6.80
PBD352303	6.80
PBL3726/6	7.20
PCB80C39-11P	7.84
PCD3311P	4.82
PCD3312P	4.73
PCF8583P	7.96
QMV16BP5	7.80
QMV18CW1	7.80
QMV24C	5.74
QMV62AW1	8.10
RC4136N	0.90
RC4207GN	2.24
RC4558C	0.60
RC4558M/SMD	0.62
RC4558P	0.77
REF01CP	1.52
REF01HP	2.98
REF02CP	2.30
REF02GP	3.20
REF03GP	1.95
REF25Z	1.12
S202DS2	4.80
SAA1027	2.65
SAA1043P	7.98
SAA5025D	6.40
SAA6002A	10.80
SAS560S	3.40
SAS570S	1.60
SFC2741DC	0.18
SL1451DP	12.44
SL1452	6.21
SL1452DP	10.01
SL1454DP	11.10
SL1455DP	12.44
SL1612CDP	5.03
SL1613CDP	3.69
SL1640CDP	7.84
SL1641CDP	7.09
SL2363CCM	12.73
SL2364CDC	14.33
SL2364CDP	4.28
SL301LCM	13.19
SL3127CDP	2.78
SL3145CDP	3.78
SL3145CMP	4.01
SL360GCM	13.91
SL362CCM	10.05
SL486DP	2.98
SL490B	2.56
SL521CCM	12.52
SL532CCM	13.61
SL541BCM	23.42
SL541BDG	19.20
SL560CCM	8.63
SL560CDP	2.96
SL560CLC	16.14
SL561CDP	4.13
SL610CCM	9.60
SL611CCM	9.60
SL612CCM	9.60
SL621CCM	18.92
SL6270C	2.76
SL6270CCM	9.35
SL6270CDP	2.75
SL6270MP	3.01
SL6310CDG	4.67
SL6310CDP	2.34
SL6310CMP	2.57
SL641CCM	10.61
SL6443CDP	4.28
SL6601CDG	8.57
SL6639MP	16.33
SL6652DG	12.38
SL6655HP	20.43
SL6700CDP	5.47

SL952DP	7.26
SN75107AN	1.57
SN75107BN	1.57
SN75108BN	2.08
SN75109AN	2.46
SN75110AN	1.57
SN75112N	4.50
SN75113N	4.57
SN75114N	4.57
SN75115N	1.20
SN75116N	3.60
SN75124N	2.42
SN75136N	3.10
SN75138N	4.41
SN75140P	3.11
SN75150P	1.62
SN75151N	5.02
SN75152N	6.36
SN75154N	1.96
SN75155P	1.36
SN75157P	5.68
SN75158P	4.94
SN75159N	5.77
SN75160BN	7.35
SN75161AN	9.31
SN75162BN	11.76
SN75172N	4.56
SN75173N	4.56
SN75174N	3.25
SN75175N	5.28
SN75176AP	1.80
SN75176BP	2.28
SN75177BP	2.74
SN75179BP	2.46
SN75182N	2.90
SN75183N	2.90
SN75188N	0.40
SN75189AN	0.85
SN75189N	0.85
SN75437ANE	3.26
SN75451	0.26
SN75451BP	0.99
SN75452BP	0.49
SN75453BP	0.99
SN75454BP	0.99
SN75462P	1.52
SN75463P	1.52
SN75468	4.33
SN75469N	4.33
SN75472P	1.89
SN75477	2.10
SN75512BN	4.76
SN75C188N	1.43
SN75C189CN	1.43
SP8660DP	3.90
STK4141II	4.70
STK4152II	7.75
TA7215P	7.20
TA7256P	2.60
TA7526P	2.60
TA78005AP	1.64
TA8410K	4.20
TBA120S	0.60
TBA120SA	1.20
TBA540	1.94
TBA570	6.90
TBA800	0.84
TBA820M	1.11
TBA920	1.60
TBA990	1.84
TCM1520AP	1.29
TDA1083	2.60
TDA1085A	2.96
TDA1085C	3.80
TDA1151	1.10
TIL113	0.66
TIL117	0.66
TIL119	0.78
TIL311	11.20
TL026CP	1.22
TL064CDP	0.48
TL081CP	0.35
TL082CP	0.40
TL084CN	0.74
TL331CP	1.23
TLC272CP	1.30
TLC555CP	0.65
TLC556CN	1.14
TLP521	0.60
TSC7126CPL	3.60
TSC7135CPI	5.98
TSC7660CPA	1.20
U1096B	4.92
U2066B	2.64
UA2240PC	1.40
UA709CP	1.40
UA723CN	0.60
UA733CN	0.60
UA741	0.18
UA748CP	0.52
UA748TC	0.52
UA78M12UC	0.40
UA9636ACP	1.86
UA9637ATC	1.35
UA9638CP	1.86
UA9639CP	1.65
UDN6118A	1.65
ULA1RB029E1	4.96
ULN2001AN	0.93
ULN2002AN	1.40
ULN2003A	0.40
ULN2003AN	0.48
ULN2004AN	1.40
ULN2803A	1.10
ULN2804AN	2.20
UM5101	3.80
XR2206CP	3.95
ZN425E-8	5.98
ZN426E-8	3.63
ZN427E-8	10.65
ZN428E-8	6.20
ZN429E-8	2.59
ZN435E	7.44
ZN439E8	7.44
ZN447E	10.88
ZN448E	7.98
ZN449E	4.76
ZN459CP	4.07

MICROPROCESSOR & SUPPORT ICs

6321P	4.20
63485CP32/SMD	32.50
63B03XP	11.95
6502	3.40
6502A	3.90
6502C	5.95
6520P	3.89
6522	3.60
6522A	7.95
6551	3.10
6551A	3.60
65C02P2	6.90
65C02P3	6.90
65C102P2	8.40
65C22P2	5.67
65C51E1	3.65
65C51E2	4.45
68000CP10	6.02
68000CP12	7.72
68000CP8	4.95
68008CP10	7.70
68008CP8	5.95
6802P	2.47
6803P	4.98
6805E2P	9.18
6810P	2.98
6821P	1.52
6840P	3.10
6844P	17.20
6845L	8.80
6845P	5.40
6845SP	6.92
68A00P	7.02
68A09P	7.63
68A21P	3.03
68A40P	4.83
68A50P	2.82
68B03P	15.25
68B09P	9.25
68B21P	4.29
68B21P	3.14
68B40P	5.22
68B45P	9.92
A80C286-12	48.60
AM9050CDC	4.95
AM9050CPC	4.60
C8253	2.85
CA80C85B	4.80
CD82C85	9.62
CD82C86H-5	9.74
CG80C286-12	48.60
CG80C286-16	58.70
D8254-2	6.42
D8282	4.20
D8284A	3.90
D8288	6.48
D82C288-8	9.36
D8748H	10.85
DP8311N	6.54
DS5000-32-12	62.98
EF6803P	4.98
F6821P	1.30
HD6321P	4.20
HD63485PS32	32.50
HD63B03XP	11.95
HD6845SP	6.92
HD68B21P	4.29
M5M82C54P-6	5.40
MAB8035HL-6P	3.50
MAB8035HP-6P	3.50
MAB8039HL-11P	5.09
MC146805E2P	9.18
MC6802P	2.47
MC6821P	1.60
MSM80C35RS	4.90
MSM80C85A	3.60
MSM80C85A-2	3.85
MSM80C86	7.60
MSM81C55	4.60
MSM82C51A	3.58
MSM82C53-2	3.98
MSM82C53-5	3.58
MSM82C54-2	4.20
MSM82C59A-2	3.98
MSM82C84A	3.30
MSM82C84A-2	3.60
MSM82C88	12.60
NS16550AFN	18.90
P8051AH	11.20
P8052AH/BASIC	23.45
P8080A	3.90
P8085A-2	3.00
P8085AH-2	3.30
P8088	4.80
P80C86AL-2	18.60
P8155H	3.50
P8185	18.10
P8205	2.00
P8212	2.40
P8226	2.40
P8228	3.86
P8251	2.45
P8251A	2.85
P8253	2.20
P8255A-5	2.40
P8259	2.60
P8259A	2.70
P8274	9.98
P8275	21.20
P8279-5	2.60
P8282	2.64
P8286	3.60
P8287	4.55
P82C54	4.10
P82C54-2	4.80
PCF8566T	4.86
PCF8573P	4.95
PCF8574P	4.15
PCF8591P	8.98
R6502AP	5.95
R6520P	3.89
R6522	3.20
R6522AP	7.95
R65C02P2	5.84
R65C02P3	6.90
R65C22P2	5.67
SCC2692BC1N40	7.98
SCN2641CC1N24	3.73
SCN2651CC1N28	9.06
SCN2652AC2N40	6.82
SCN2661AC1N28	3.74
SCN2661BC1N28	3.60
SCN2661CC1N28	3.60
SCN2672BC3N40	8.84
SCN2672BC4N40	6.42
SCN2673AC5N40	10.53
SCN2674BC3N40	10.24
SCN2674BC4N40	8.42
SCN2681AC1N24	6.52
SCN2681AC1N28	6.52
SCN2681AC1N40	5.85
SCN2691AC1A24	4.92
SCN2691AC1A28	6.65
SY6522	3.20
SY6522A	3.80
SY6551	3.90
TMP8085AP-2	3.60
TMS3477NL	12.10
TMS77C01NL	2.85
TMS9900NL	24.40
TMS9901NL	7.22
TMS9902ANL	7.98
TMS9902NL	7.34
TMS9914ANL	18.94
TMS9928ANL	4.70
TMS9995JDL	69.85
UM82C288-10	6.80
UM82C50A	5.60
UMC82C284-12	4.80
UMC82C288-12	4.80
UPB8282C	3.80
UPB8284AD	3.60
UPB8286C	3.80
UPD70108C-8	6.95
UPD70108C-10	9.10
UPD70116C-8	9.20
UPD70116C-10	12.90
UPD7201AC	6.80
UPD7201C	6.80
UPD765AC	5.42
UPD8085AC-2	4.96
UPD8085AHC-2	6.46
UPD80C39HC	8.42
UPD80C40HC	13.84
UPD8243HC	2.60
UPD8251AFC	5.78
UPD8253C-2	3.32
UPD8253C-5	3.32
UPD8255AC-2	3.20
UPD8255AC-5	3.20
UPD8259AC	3.34
UPD8259AC-2	3.60
UPD8279C-5	5.40
UPD8741AD	12.52
UPD8749HC	13.98
V20-8MHz	6.95
V20-10MHz	9.10
V30-8MHz	9.20
V30-10MHz	12.90
Z80-DMA	4.45
Z80-PIO	1.86
Z80A-CPU	1.25
Z80A-CTC	1.72
Z80A-DART	3.26
Z80A-PIO	1.61
Z80A-SIO/O	3.40
Z80B-CPU	1.90
Z80B-CTC	3.00
Z80B-DART	5.80
Z80B-PIO	2.20
Z80B-SIO	4.50
Z8001B-CPU	1.96
Z8018008VSC	8.25

MATHS CO-PROCESSOR

AM9511-4DC	48.85
AM9511A-4DC	58.30
D80287-10/INT	127.00
D80287-8/INT	122.00
80287XL/INT	127.00
BOX287XL/INT	127.00

MEMORIES DYNAMIC RAM

4164-10	1.40
4164-12	1.00
41256-8	1.60
41256-10	1.50
41256-12	1.40
41464-12	2.50
41464-10	2.50
44C256AZ-10	8.95
44C256-8	5.00
511000-85	8.80
HM48416AP-15	4.60
HM48416AP-20	4.25
HYB511000-85	8.80
KM41256AP-12	1.68
KM44C256AZ10	8.95
MK4116N-54	2.78
MK4564N-15	1.45
NMC3764N-15	1.80
TMM4164AP-15	1.75
TMS4164-12NL	1.00
UPD41256C-15	2.80
UPD41464-12	3.50
UPD41464C-15	3.50
UPD4164C-3	1.20
UPD416C-2	3.40
UPD416C-3	3.65
UPD446D-1	2.60

STATIC RAM

2114-3L	2.20
6264LP-10	2.40
6264LP-12	2.40
62256LP-12	4.95
62256LP-10	4.95
CDM6116AE3	5.30
CDM6117AE3	5.85
HM1-6116-5	2.50
HM3-6116-5	3.15
HM6116LP-2	2.60
HM6116LP-3	2.60
HM6117LP-3	3.40
HM62256LP-12	7.50
HM6264ALP-12	4.20
HM6264ASP-20	3.40
HM6267P-35	6.25
HM628128LP-80	25.50
HM66204L-12	23.20
KM62256ALP-10	4.95
LH5164D-10L	2.40
M5M4464P-15	5.80
MCM2114P45	2.00
MM2102AN-2L	2.80
MSM2114L-3RS	2.40
P2114AL-2	2.98
P2114AL-4	2.40
PCD5101P	3.60
TMM2016AP-10	3.80
UPD2114LC-5	2.80
UPD4016C-1	3.80
UPD4016C-5	3.80
UPD43256AGU10L	25.20
UPD43256C-12	5.60
UPD4364C-15	2.80

UVPROMS

27C128-25	2.95
27C64AD-15	2.74
27C256-15FA	3.95
D27256	4.35
HM27C101G-20	11.40
HN27C1024HC-10	37.50
HN27C64FP-20T	5.95
HN27C64G-15	4.20
HN27C64G-20	3.80
HN462532	4.50
HN462532P	3.60
HN462716G	3.40
HN4827128G-25	4.55
HN482764G	3.80
HY53C256LS-80	3.20
HY6264LP-10	2.40
M2716-1F1	3.15
M5L27128K	5.60
M5L2732K	4.40
M5L2764K	3.30
MBM27C128-25	5.80
MBM27C256-25	5.10
MBM27C256-30	5.10
NMC27C16Q-45	4.98
NMC27C256Q-25	3.95
NMC27C64Q-25	3.30
TC57256D-25	5.40
TMS2516JL-45	4.58
TMS27128JL-25	4.60
TMS27128NL-25	4.60
TMS2716JL-45	4.60
UPD27256D/21V	4.60
UPD2732A/21V	4.40
UPD27C256AD-15	5.40
UPD27C512D-15	5.80
UPD27C64D-25	3.85

EEPROMS

AT28C256-15DC	49.80
AT28C64-25	9.80
AT28C64-15	10.95
KM28C256-20	28.45
KM28C256-15	47.60
KM28C64-25	9.80
X2816AD	6.62
X2816AP-25	6.70
X2864AP-35	12.20

MISC MEMORIES

6341-1J	4.58
AM2148-45DC	5.44
AM27S281PC	3.98
IDT7130LA-100P	12.42
IDT7132LA-100P	14.42
IDT7132S-100C	14.42
MB8414E	5.85
MCM4027AC3	1.80
N82S126AN	1.68
N82S153N	5.80
N82S181F	6.80
NMC6504J-9	3.60
NMC9306N	1.70
P5101L-1	3.90
TBP18S030N	1.76
TBP24S10N	2.60
TBP24SA10N	2.95
TC5501P	3.50
TC5504AP-2	3.40
TC5516PL-15	4.20
TC5517AP-2	4.20
TC5565PL-15	3.60
TMM2068D-45	6.80
TMS4014JDL	3.40
TMS4014NL	2.95
TMS4016-15NL	2.80

We stock DIN 41462, IDC & 'D' Connectors, PCB Pin Headers, LEDs, LCD Displays, Relays. Also Resistors and Capacitors, including Surface Mount.

VIEWCOM ELECTRONICS
77 UPPERTON ROAD WEST
PLAISTOW, LONDON E13 9LT

PLEASE PHONE/WRITE FOR ITEMS NOT LISTED

PLEASE ADD 85p P&P and then 17·5% VAT. OFFICIAL ORDERS from Govt. & Educational Establishments are accepted. OVERSEAS orders, postage AIR/SURFACE charged at cost. VAT not applicable for EXPORT orders. Stock items by return of post.
N.B. Prices subject to change without notice & stock availability.

Retail Shop: 139 New City Road, Plaistow, London E13 9PX

MARCO TRADING

December Special Offers

INCORPORATING EAST CORNWALL COMPONENTS
ELECTRONIC COMPONENTS & EQUIPMENT
MAIL ORDERS • WHOLESALE RETAIL

SEND ORDERS TO – DEPT 12

MARCO TRADING
THE MALTINGS, HIGH STREET, WEM
SHROPSHIRE SY4 5EN
Tel: (0939) 32763 Telex: 35565
Fax: (0939) 33800
ELECTRICAL & ELECTRONIC
COMPONENT SUPPLIERS

24HR ANSAPHONE

VISIT

OUR OTHER BRANCHES

SUPERTRONICS
Tel: 021 666 6504
65 HURST STREET
BIRMINGHAM B5
4TE

WALTONS
Tel: 0902 22039
55A WORCESTER ST
WOLVERHAMPTON
WV2 4LL

LATEST 1992 CATALOGUE

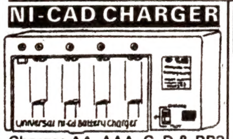
- ★ Velleman Kit Catalogue
- ★ Free pre-paid envelope
- ★ Many new lines
- ★ Pages of special offers
- ★ Free gifts

132 PAGES

POST & PACKING IS NOW £2.25

ALL PRICES INCLUDE 17½% VAT

NI-CAD CHARGER



Charges AA, AAA, C, D & PP3 Ni-Cads
240V AC
£4.99

VHS VIDEO TAPES

VHS – JVC
3 HOUR
£1.99 each
10 for
£1.75

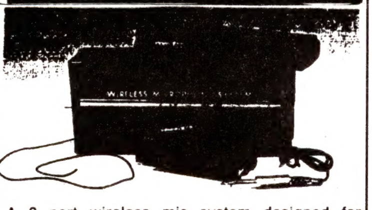
NI-CAD RECHARGEABLE BATTERIES

	PRICE 1+	EACH 10+
AAA	£1.50	£1.30
AA	95p	85p
C	£1.95	£1.80
D	£2.00	£1.85
PP3	£3.90	£3.75

MAXELL TAPES

UDI-90
90 MINS
£7.50 for 10

VIDEO – WIRELESS MICROPHONE – HAND HELD



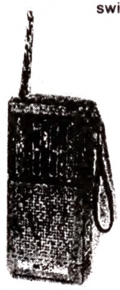
A 2 part wireless mic system designed for use with video camcorders. Microphone has HIGH/LOW power switch to select the transmission range up to 200ft. The receiver has a mounting shoe for fixing to the camcorder. Volume control and lead with 3.5mm jack plug. Complete with vinyl carrying case

ORDER CODE: MIC/G210

PRICE £33.99

BROADBAND RADIO RECEIVER

A hand-held broadband radio receiver with a range covering CB, FM radio, TV, Air and PB bands. Built-in telescopic aerial. Squelch, volume and tuning controls and band selector switch.



FREQUENCY RANGE:

AM	108-145MHz
PB	145-176MHz
Wb	162.5MHz
TV	54-87MHz
FM	88-108MHz
CB	1-80 channels

Power 6V d.c.
(4 x AA batteries, not included)
Dims 93 x 198 x 50

Price: £17.50

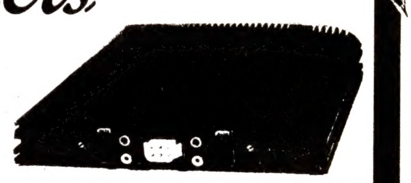
ORDER CODE: CAR/CPA100

2 x 60W CLASS "A" AMPLIFIER B005LA (CPA 100)

Class "A" stereo in-car amplifier capable of delivering 2 x 60W stereo or 120W mono in bridge mode. Inputs are low level phono, with left and right level controls. Full thermal and overload protection.

Output power ....2 x 60W stereo 0.1%THD
120W mono 0.1% THD
Signal to noise ratio .... >80dB
Frequency response..................................20-20000Hz
Input sensitivity...........................100mV-3V adjustable
Input impedance..Low level input 20kΩ
Output impedance...........................4Ω
Power ....14.4V dc 15A
Dims ....240 x 120 x 50mm

£39.99



ORDER CODE: CAR/CPA504

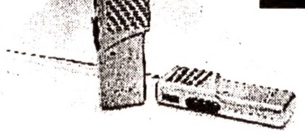
4 x 120W CLASS "A" AMPLIFIER B005N (CPA 504)

High power 4-channel Class "A" amplifier, capable of delivering 4 x 120W or 2 x 240W in bridge mode. Inputs are direct from the speaker outputs of the car radio cassette, or low level phono inputs with left and right level controls. Full thermal overload protection.

Output power ....4 x 120W or 2 x 240W (bridged)
Signal to noise ratio.. >90dB
Frequency response.. 10-50000Hz
Input sensitivity.......................................100mV-3V adjustable
Input impedance......High level input 100Ω
Low level input 20Ω
Power..................................14.4V dc 60A
Dims...............................400 x 240 x 50mm

£119

ATTENTION RETAILERS
Wholesale/Qty prices are available on these amplifiers



CAT NO GE9885

2-WAY HAND HELD B 123

2-WAY Hand Held Crystal Control Tranceivers. Built-in Telescopic Aerial, call button, transmiter receive key, on air indicator. Each unit requires PP3 battery for operation (not supplied)

Operating Frequency...49 MHz
Transition Power..100 MHz
Frequency Tolerance .... + or –0.005%
Range....... 1-2 Kilo. open field (Depends on conditions)
Oscillation..Crystal Control
Power Pack ....9V DC (PP3 batttery. 1 pair in box)

£26.50

B118D 12-BAND RECEIVER

A compact 12-band radio receiver covering FM, MW, LW, and 9 short wave bands. A built-in ferrite bar antenna receives the MW and LW transmissions and the telescopic rod antenna receives FM and SW transmissions. An additional 20ft wire antenna is provided to improve SW reception. The tuning LED lights when a strong signal is present. Wave band selection, tone and volume is by slider controls.

Frequency coverage

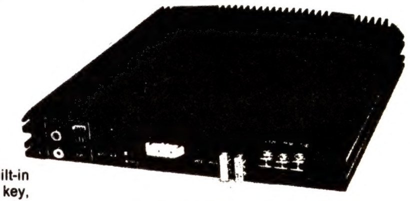
FM	66 to 108MHz	SW4	11.45 to 12.23MHz
MW	530 to 1620kHz	SW5	13.40 to 14.15MHz
LW	150 to 270kHz	SW6	14.85 to 15.70MHz
SW1	5.85 to 6.23MHz	SW7	17.35 to 18.35KHz
SW2	6.95 to 7.42MHz	SW8	20.80 to 22.15MHz
SW3	9.45 to 9.95MHz	SW9	24.95 to 26.50MHz

Power: 6V dc (4 x AA batteries
Dims: 196 x 35 x 123mm

£21.50

CD PLAYER

3-beam semiconductor laser. 6 track programmable memory. Repeat one – repeat all. Built-in 3 disc adaptor. **£99**



ORDER CODE CAR/CPA200

2 x 200 CLASS "A" AMPLIFIER B005M CPA200

High power Class A amplifier capable of delivering 2 x 200W stereo or 400W mono in bridge mode. Inputs are direct from the speaker outputs of the car radio/cassette or low level phono inputs, with left and right level controls. Full thermal and overload protection.

Output power ....2 x 200W stereo 0.08% THD
400W mono 0.2% THD
Signal to noise ratio .... >90dB
Frequency response.............................10-50000Hz
Input sensitivity.....................100mV-3V adjustable
Input impedance...................High level input 100Ω
Low level input 20kΩ
Output impedance..4Ω
Damping factor................................. >180 into 4Ω
Power ....14.4V dc 43A nom
Dims ....240 x 130 x 50mm

£107

SOLDER 18 & 22 SWG -500gm REEL

	1+	10+
18swg	£4.95	£4.70
22 swg	£4.99	£4.75

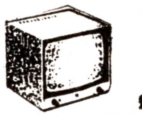
Remember: Our prices INCLUDE VAT!

CLOSED CIRCUIT TELEVISION SYSTEM

1 x CAMERA

USED
£120

1 X CAMERA BRACKET
£7.75
NEW



Complete price
£185
Plus £10 carr

£70 USED
1 X MONITOR

FM TRANSMITTER

Made in U.K.

Very high quality 'Mini-Bug – ideal for baby alarm, etc!! A very good range is obtainable – we have obtained over ½ mile, but it does depend on conditions. Simply remove cover – insert battery – and you'r ready to go. Reception can be obtained on any FM radio.

Frequency 105-109MHz FM

ORDER CODE SEC/FMB1

PRICE: £9.99

FM KIT

For those of you who enjoy building kits – we now offer the above transmitter in kit form. Ideal for the beginner – supplied complete with full, easy to follow instructions..Box NOT INCLUDED – See our BOXES Section for suitable housing.

ORDER CODE SEC/FMKIT

PRICE: £7.50

HOME ALARM PACKAGE

Includes:
- ★ Optima Alarm Control Panel
- ★ External Red Bell Box
- ★ 2 x 1 Internal Passive I.R.
- ★ 2 x Door Contacts
- ★ Siren for bell box
- ★ 100 mtrs. cable and clips
- ★ Full fitting instructions

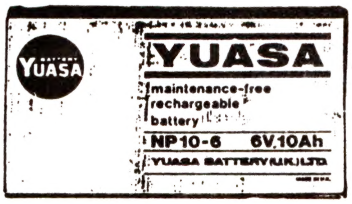
ONLY £130

★ **BACK-UP LEAD ACID BATTERY**
12V 1.9Ah
★ **£15.27**

★ **LEAD ACID CHARGER**
£19.99

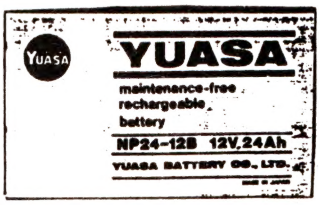
YUASA SEALED LEAD ACID BATTERY OFFER

We have just purchased over 500 sealed lead acid batteries. Because we bought so many we can offer you a very, very low price. All the batteries are brand new, unused, full spec. etc. etc. We have indicated below the current price for batteries so you can see what a bargain they really are. However, demand will be high and so do not delay, this offer cannot be repeated.



1+ SUPER PRICE!
£10.50
Two for £19.00

£35.00
Two for £60.00



YUASA CODE	DIMENSIONS H		W		D	Max Initial Charge Current	CHARGE VOLTAGE Cyclic 2.5V/Cell	Standby 2.3V/Cell	Number Of Cells	Maplin Price
NP10-6	101	X	151	X	50mm	2.5A	7.5	6.9	3	£17.95
NP24-12B	125	X	166	X	175mm	6.0A	15	13.8	6	£59.95

Weights: NP10-6 2.2Kg NP24-12B 22.7Kg NP24-12B has bolt style terminals NP10-6 is spade style

Special Prices on Crotech Test & Measuring Instruments & Audio Test Equipment

WHILE STOCKS LAST

ALL PRICES INCLUDE VAT & DELIVERY

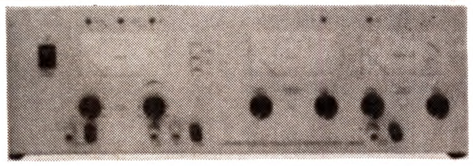
Crotech

TYPE 3132

DUAL TRACE OSCILLOSCOPE

- ★ DC-20MHz
- ★ 2mV Sensitivity
- ★ 0.5µs-0.2µs/div. Timebase
- ★ Versatile Trigger
- ★ TV/ALT, DC, Mains, +/− slope variable hold off
- ★ X-Y Mode
- ★ Component Tester
- ★ Triple DC source +5V/1A, ±12V/200mA

£249 Originally £355



Crotech

LAB 532

MULTIPLE OUTPUT POWER SUPPLY

- ★ 0-30V, 0-2A } Constant Voltage or Constant Current
- ★ ±15V at 0.5A Constant Voltage with current foldback
- ★ 5V/5A Constant Voltage with current foldback
- ★ Separate meters for 30V output

£215 Originally £380

Crotech

TYPE 2018

AUDIO FREQUENCY OUTPUT POWER METER

- ★ RANGES: 5mW-150mW
- ★ LOAD: 12 impedances switch selectable 4, 8, 16, 50, 75, 150, 600, 1k, 2k, 5k and 10kΩ
- ★ Auto trip overheat facility

£175 Originally £262

METEX

DIGITAL MULTIMETER

- ★ DC Voltage: 200mV-1000V
- ★ AC Voltage: 200mV-750V
- ★ DC Current: 200µA-20A
- ★ AC Current: 200µA-20A
- ★ Overload protected 200mA/250V

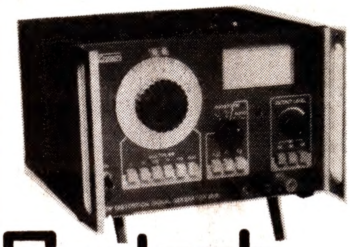
£49 Originally £80

Crotech

307 TRI-PROBE

PASSIVE SCOPE PROBE with X1 and X10 setting

£10 Originally £16



Crotech

TYPE 2016

LOW DISTORTION SIGNAL GENERATOR

- ★ Sine Wave output 3V rms into 600Ω
- ★ Square Wave output 3V pk-pk into 600Ω
- ★ Sine Wave burst 1.5V pk-pk into 600Ω
- ★ Frequency range 1Hz-1MHz

£155 Originally £216

ORDER FORM

Name: ....

Address:...............................

....

....

....

Qty	Type	Price each	Total
	3132	£249	
	2018	£175	
	2016	£155	
	532	£215	
	307	£10	
	METEX	£49	

TOTAL Inc. VAT and Delivery } : ....

I enclose my cheque No. .... for £........................Access/Visa Cards accepted

Please allow 28 days for delivery.

Crotech Instruments Ltd.
Unit A1, Faraday Road,
Newbury, Berks. RG13 2AD

MAGENTA ELECTRONICS LTD

MAIL ORDER AND SH
EE1
135 Hunter
Burton-on-Tre
Staffs, DE14 2
Tel: 0283 654
Fax: 0283 469

All prices include VAT at 17½%
Shop open 9-5 Mon-Fri;
9-2 Saturday
Official orders welcome

Add £2 p&p to all orders

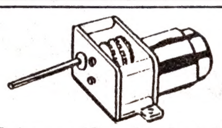
PORTABLE ULTRASONIC PEsT SCARER

EE AUG '91

A powerful 23kHz Ultrasonic generator in a compact hand-held case. A MOSFET output drives a weatherproof transducer at up to 300V peak to load via a special tuned transformer. Sweeping frequency output requires no setting up or alignment. Kit includes all components, PCB, transducer and case.

KIT REF 842 KIT PRICE **£22.56**

D.C. MOTOR GEARBOXES



Ideal for Robots and Buggies. A miniature plastic reduction gearbox coupled with a 1·5-4·5 Volt mini motor. Variable gearbox reduction ratios are obtained by fitting from 1 to 6 gearwheels (supplied). Two types available:

SMALL UNIT TYPE MGS **£4.08**
Speed range 3-2200 rpm. Size 37×43×25mm

LARGE UNIT TYPE MGL £4.65
Speed range 2-1150 rpm. Size 57×43×29mm

Supplying Electronics for Education, Robotics, Music, Computing and much, much more!

CATALOGUE AVAILABLE PRICE £1.00 INC. P&P

STEPPING MOTORS

A range of top quality stepping motors suitable for driving a wide range of mechanisms under computer control using simple interfacing techniques.

ID36 PERMANENT MAGNET MOTOR– **£16.86**
48 steps per rev

MD200 HYBRID MOTOR– **£17.10**
200 steps per rev

MD35 ¼ PERMANENT MAGNET MOTOR– **£12.98**
48 steps per rev.

MD38 PERMANENT MAGNET MOTOR– **£9.15**
48 steps per rev.

EVERYDAY ELECTRONICS KIT PROJECTS

ALL KITS HERE HAVE BEEN FEATURED IN EE AND ARE SUPPLIED WITH MAGAZINE ARTICLE REPRINTS. SEPARATE REPRINTS ALSO AVAILABLE PRICE 80p EACH INCLUSIVE P&P. KITS INCLUDE CASES, PCB's HARDWARE AND ALL COMPONENTS (UNLESS STATED OTHERWISE) CASES ARE NOT DRILLED OR LABELS SUPPLIED UNLESS STATED.

Ref		Price
842	PORTABLE ULTRASONIC PEsT SCARER, Aug '91	£22.56
841	DIGITAL LCD THERMOSTAT May 91 with punched and printed case	£29.95
840	DIGITAL COMBINATION LOCK Mar 91 with drilled case	£19.86
839	ANALOGIC TEST PROBE Jan 91	£13.23
838	MICROCONTROLLER LIGHT SEQUENCER Dec 90. With drilled and labelled case	£57.17
835	SUPERHET BROADCAST RECEIVER Mar 90 With drilled panels and dial	£17.16
834	QUICK CAP TESTER Feb 90	£10.39
833	EE 4 CHANNEL LIGHT CHASER Jan 90	£32.13
815	EE TREASURE HUNTER Aug 89	Full Kit £45.95
814	BAT DETECTOR June 89	£21.44
812	ULTRASONIC PET SCARER May 89	£14.81
800	SPECTRUM EPROM PROGRAMMER Dec 88	£30.60
796	SEASHELL SYNTHESISER Nov 88	£28.55
790	EPROM ERASER Oct 88	£28.51
769	VARIABLE 25V-2A BENCH POWER SUPPLY Feb 88	£56.82
744	VIDEO CONTROLLER Oct 87	£33.29
740	ACOUSTIC PROBE Nov 87	£20.01
739	ACCENTED BEAT METRONOME Nov 87	£23.94
734	AUTOMATIC PORCH LIGHT Oct 87	£19.62
730	BURST-FIRE MAINS CONTROLLER Sep 87	£15.50
728	PERSONAL STEREO AMP Sep 87	£16.34
724	SUPER SOUND ADAPTOR Aug 87	£43.86
722	FERMOSTAT July 87	£13.88
719	BUCCANEER I.B. METAL DETECTOR July 87	£30.22
718	3-BAND 1.6-30MHz RADIO Aug 87	£30.30
715	MINI DISCO LIGHTS June 87	£14.39
707	EQUALIZER (IONISER) May 87	£17.75
700	ACTIVE I/R BURGLAR ALARM Mar 87	£40.74
584	SPECTRUM SPEECH SYNTH (no case) Feb 87	£23.90

Ref		Price
581	VIDEO GUARD Feb 87	£9.59
569	CAR ALARM Dec 86	£14.24
563	200MHz DIG. FREQUENCY METER Nov 86	£71.47
561	LIGHT RIDER LAPEL BADGE Oct 86	£11.65
560	LIGHT RIDER DISCO VERSION Oct 86	£22.41
559	LIGHT RIDER 16 LED VERSION Oct 86	£15.58
556	INFRA-RED BEAM ALARM Sep 86	£32.39
544	TILT ALARM July 86	£8.94
542	PERSONAL RADIO June 86	£13.17
528	PA AMPLIFIER May 86	£30.60
523	STEREO REVERB Apr 86	£30.21
513	BBC MIDI INTERFACE Mar 86	£31.93
512	MAINS TESTER & FUSE FINDER Mar 86	£10.07
497	MUSICAL DOOR BELL Jan 86	£21.41
493	DIGITAL CAPACITANCE METER Dec 85	£49.95
481	SOLDERING IRON CONTROLLER Oct 85	£6.25
464	STEPPER MOTOR INTERFACE FOR THE BBC COMPUTER less case Aug 85	£9.60
	1D35 STEPPER MOTOR EXTRA	£9.15
	OPTIONAL POWER SUPPLY PARTS	£5.86
461	CONTINUITY TESTER July 85	£7.08
455	ELECTRONIC DOORBELL June 85	£8.63
444	INSULATION TESTER Apr 85	£22.37
392	BBC MICRO AUDIO STORAGE SCOPE INTERFACE Nov 84	£40.82
387	MAINS CABLE DETECTOR Oct 84	£6.31
386	DRILL SPEED CONTROLLER Oct 84	£9.91
362	VARICAP AM RADIO May 84	£15.02
337	BIOLOGICAL AMPLIFIER Jan 84	£27.59
263	BUZZ OFF Mar 83	£6.49
242	INTERCOM no case July 82	£6.50
240	EGG TIMER June 82	£7.85
108	IN SITU TRANSISTOR TESTER June 78	£10.76
106	WIERD SOUND EFFECTS GEN Mar 78	£8.94
101	ELECTRONIC DICE Mar 77	£7.15

HAMEG HM 203-7 OSCILLOSCOPE

New model just arrived. High quality reliable instrument made in W. Germany. Outstanding performance.
Full two year parts and labour warranty.
20MHz-2 channels 1mV sensitivity
Easy to operate and high performance

£338
+ **£59.15** VAT
Next Day Delivery **£10.00**
(cheques must be cleared)

EDUCATIONAL BOOKS & BOOK PROJECTS

ADVENTURES WITH ELECTRONICS

The classic Easy to Follow book suitable for all ages. Ideal for beginners. No soldering, uses an S-DEC breadboard. Gives clear instructions with lots of pictures. 16 projects — including three radios, siren, metronome, organ, intercom, timer, etc. Helps you learn about electronic components and how circuits work. Component pack includes an S-DEC breadboard and all the components for the series.

ADVENTURES WITH ELECTRONICS	£5.75
COMPONENT PACK (less book)	£22.83

FUN WITH ELECTRONICS

From the USBORNE Pocket Scientist series — An enjoyable introduction to electronics. Full of very clear full colour pictures accompanied by easy to follow text. Ideal for all beginners — children and adults. Only basic tools are needed. 64 full colour pages cover all aspects — soldering — fault finding — components (identification & how they work). Also full details of how to build 6 projects — burglar alarm, radio, game, etc. Requires soldering — 4 pages clearly show you how.

The components supplied in our pack allows all the projects to be built and kept. The book is available separately.

FUN WITH ELECTRONICS Book	£2.95
COMPONENT PACK (less book)	£17.93

30 SOLDERLESS BREADBOARD PROJECTS

A book of projects by R. A. Penfold covering a wide range of interests. All projects are built on a Verobloc breadboard. Full layout drawings and component identification diagrams enable the projects to be built by beginners. Each circuit can be dismantled and rebuilt several times using the same components. The component pack allows all projects in the book to be built one at a time.

Projects covered include amplifiers, light actuated switches, timers, metronome, touch switch, sound activated switch, moisture detector, M.W. Radio, Fuzz unit, etc.

30 SOLDERLESS BREADBOARD PROJECTS Book 1	£2.95
COMPONENT PACK	£27.74

ENJOYING ELECTRONICS

A more advanced book which introduces some arithmetic and calculations to electronic circuits. 48 chapters covering elements of electronics such as current, transistor switches, flip-flops, oscillators, charge, pulses, etc. An excellent follow-up to Teach-in or any other of our series. Extremely well explained by Owen Bishop who has written many excellent beginners' articles in numerous electronics magazines.

ENJOYING ELECTRONICS Book	£3.60
COMPONENT PACK	£14.62

Note – A simple multimeter is needed to fully follow this book. The M102 BZ is ideal. **£13.98**

A FIRST ELECTRONICS COURSE

A copiously illustrated book that explains the principles of electronics by relating them to everyday objects. At the end of each chapter a set of questions and word puzzles allow progress to be checked in an entertaining way. An S-DEC breadboard is used for this series – soldering is not required.

A FIRST ELECTRONIC COURSE BOOK	£4.99
PACK	£22.83

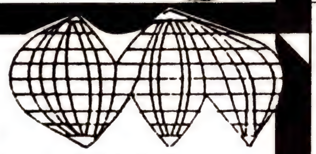
INSULATION TESTER

EE APRIL 85

A reliable electronic tester which checks insulation resistance of wiring appliances etc., at 500 volts. The unit is battery powered simple and safe to operate. Leakage resistance of up to 100 Megohms can be read easily. One of our own designs and extremely popular.

KIT REF 444

£22.37



3 BAND SHORT WAVE RADIO

EE AUG 87

Covers 1.6–30 MHz in 3 bands using modern miniature coils. Audio output is via a built-in loudspeaker. Advanced design gives excellent stability, sensitivity and selectivity. Simple to build.

KIT REF 718

£30.30

DIGITAL FREQUENCY 200 MHz METER

EE NOV 86

An 8 digit meter reading from AF up to 200 MHz in two ranges. Large 0.5" Red LED display. Ideal for AF and RF measurements. Amateur and C.B. frequencies.

KIT REF 563

£71.47

EE EQUALISER

EE MAY '87

A mains powered Ioniser with an output of negative ions that give a refreshing feeling to the surrounding atmosphere. Negligible current consumption and all-insulated construction ensure that the unit is safe and economical in use. Easy to build on a simple PCB.

KIT REF 707

£17.75

LIGHT RIDERS

EE OCT '86

Three projects under one title – all simulations of the Knight Rider lights from the TV series. The three are a lapel badge using six LEDs, a larger LED unit with 16 LEDs and a mains version capable of driving six main lamps totalling over 500 watts.

KIT REF 559 CHASER LIGHT	**£15.58**
KIT REF 560 DISCO LIGHTS	**£22.41**
KIT REF 561 LAPEL BADGE	**£11.65**

PET SCARER

EE MAY 89

Produces high power ultrasound pulses. L.E.D. flashes to indicate power output and level. Battery powered (9V–12V or via Mains Adaptor).

KIT REF 812

Mains Adaptor £2.02

£14.81

DIGITAL COMBINATION LOCK

EE MAR '91

Digital combination lock with a 12 key keypad. 4 digit code operates 250V-16A SPCO relay. A special anti-tamper circuit allows the relay to be mounted remotely from the keypad without any loss of security. Can be operated in many modes (latching/unlatching, manual/automatic setting, continuous/momentary output, etc.). Article describes operation as Vehicle Immobilising security system. Low current drain. *Kit includes drilled case.*

KIT REF 840

£19.86

ACOUSTIC PROBE

EE NOV '87

A very popular project which picks up vibrations by means of a contact probe and passes them on to a pair of headphones or an amplifier. Sounds from engines, watches and speech travelling through walls can be amplified and heard clearly. Useful for mechanics, instrument engineers and nosey parkers!

KIT REF 740

£20.01

MICROCONTROLLER LIGHT SEQUENCER

EE DEC '90

A superb kit with pre-drilled painted and silk screen printed case for a really professional finish. This kit uses a microcontroller I.C. to generate 8-channel light sequences.. Sequences are selected by keypad from over 100 stored in memory. Space for 10 user programmed sequences up to 16 steps long also available. 1000 watts per channel, zero volt switching, inductive load capability. Opto-isolated for total safety. Many other features. Complete kit includes case, PCBs, all components and hardware.

KIT REF 838

£57.17

EE TREASURE HUNTER

EE AUG '89

A sensitive pulse induction Metal Detector. Picks up coins and rings etc., up to 20cms deep. Low "ground effect". Can be used with search-head underwater. Easy to use and build, kit includes search-head, handle, case, PCB and all parts as shown.

KIT REF 815

Including headphones

£45.95

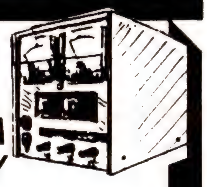
DIGITAL LCD THERMOSTAT

EE MAY '91

A versatile thermostat with LCD read out. MIN/MAX temperature recording, clock and individually settable upper and lower switching points. Covers –10 to 110 degrees Celsius, accurate to within 0.1 degrees. Submersible probe on 3 meter lead. Kit includes punched and printed case. Save on energy bills by improved control of your hot water system. Also ideal for greenhouse soil temperature and aquarium control. Complete kit includes thermostat and probe, mains power supply and relay output, PCB's and punched and printed case.

KIT REF 841

£29.95



MOSFET VARIABLE BENCH 25V 2.5A POWER SUPPLY

EE FEB 88

A superb design giving 0.25V and 0-2.5A. Twin panel meters indicate Voltage and Current. Voltage is variable from zero to 25V. A Toroidal transformer MOSFET power output device, and Quad op-amp IC design give excellent performance.

KIT REF 769

£56.82

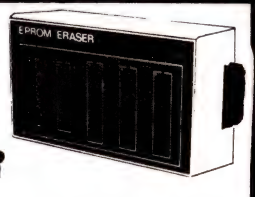
4 CHANNEL LIGHT CHASER

EE Jan '90

A 1000W per channel chaser with zero volt switching, hard drive, inductive load capability, mic sound sensor and sophisticated 'beat' detector. Chase steps to music or auto when quiet. Variable speed and mic. sens. LED mimic on front panel. Switchable for 3 or 4 channels. P552 output. Ideal for rope lights, pin spots, disco and display lighting.

KIT REF 833

£32.13



EPROM ERASER

EE OCT '88

Safe low-cost unit capable of erasing up to four EPROM's simultaneously in less than twenty minutes. Operates from a 12V supply. Safety interlock. Convenient and simple to build and use.

KIT REF 790

£28.51

SUPERHET BROADCAST RECEIVER

EE MAR '90

At last, an easy to build **SUPERHET** A.M. radio kit . Covers Long and medium Wave bands. built in loudspeaker with 1 watt output. Excellent sensitivity and selectivity provided by ceramic I.F. filter. Simple alignment and tuning without special equipment. Kit available less case, or with pre-cut and drilled transparent plastic panels and dial for a striking see-through effect.

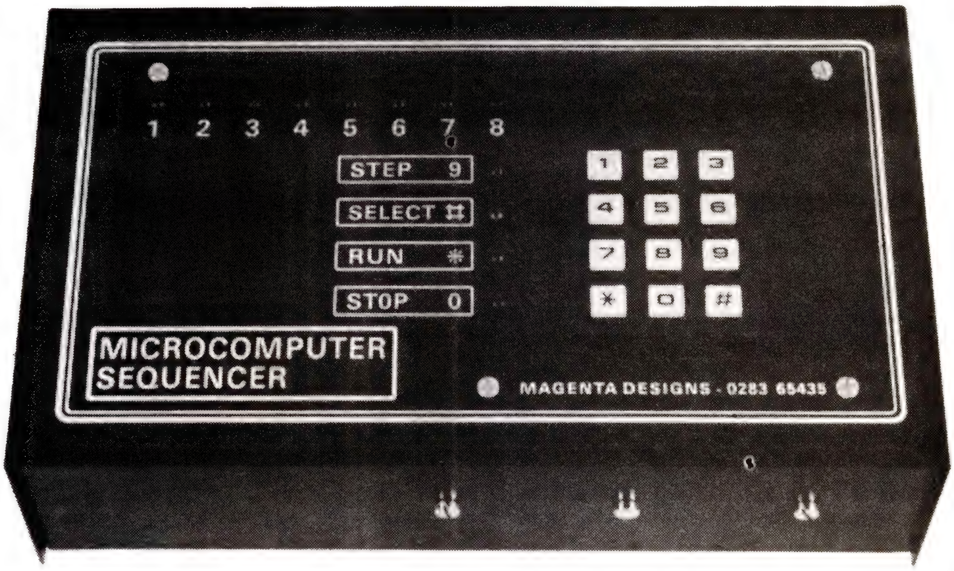
KIT REF 835

£17.16

8 CHANNEL PROGRAMMABLE SEQUENCER

A superb 8 Channel Microprocessor controlled light sequencer kit complete with a punched, painted and screen printed steel case. Absolutely ALL components and hardware supplied in this Magenta Top Kit, including 2 PCBs, heatsink, and 2 P552 output sockets.

- *8 Isolated tab 10A 600V triacs. Individually fused.*
- *Inductive load capability and Zero Volt switching*
- *Fully opto-isolated control board*
- *Custom micro. has 80 pre-programmed sequences*
- *RAM area for user sequences from 2 to 160 steps long. Battery backed*
- *LED function and mimic indicators*
- *Keypad selection of all functions, including manual operation, sequence selection and speed control*
- *Use with existing 3 and 4 channel lights or make new 8 channel specials*



"An exceptional project with many novel features and a high standard of finish which matches professional Disco equipment costing much more"

KIT REF. 838....£57.17

Outputs via 2 P551 plugs price..............£3.95 each

DIGITAL CAPACITANCE METER

A wonderfully easy to use instrument giving direct read-out of capacitors from 1pF to 1000uF. Quick and accurate to use even by absolute beginners. 1% accuracy circuit using close tolerance charging resistors and quartz crystal timing.

- *Kit includes punched and printed case, PCB, and all components.*
- *Large bright 5 Digit LED display*
- *Direct read-out in uF, pF, nF*
- *Calibration not required*

KIT REF. 493..£49.95

MAGENTA ELECTRONICS LTD

ORDER AND SHOP
EE114
135 Hunter Street
Burton-on-Trent
Staffs, DE14 2ST
Tel: 0283 65435
Fax: 0283 46932

EVERYDAY
ELECTRONICS
INCORPORATING ELECTRONICS MONTHLY

The No.1 Magazine for Electronic & Computer Projects
VOL. 20 No. 12 DECEMBER '91

Editorial Offices:
EVERYDAY ELECTRONICS EDITORIAL,
6 CHURCH STREET, WIMBORNE,
DORSET BH21 1JH
Phone: Wimborne (0202) 881749
Fax: (0202) 841692. DX: Wimborne 45314.
See notes on **Readers' Enquiries** below – we regret that lengthy technical enquiries cannot be answered over the telephone.

Advertisement Offices:
EVERYDAY ELECTRONICS ADVERTISEMENTS,
HOLLAND WOOD HOUSE, CHURCH LANE,
GREAT HOLLAND, ESSEX CO13 0JS.
Phone (0255) 850596

WIDE RANGE

I doubt if *Everyday Electronics* has ever before appealed to such a wide range of readership in any single issue. Our *Information Technology* series is in its infancy and, at this stage, designed to provide information and ideas to those teaching in junior or first schools; although most of us will find some of the information refreshes the brain – or indeed fills in a few gaps.

On the other hand the *Mind Machine* project can be said to be at the forefront of its field and will interest many people outside of electronic engineering as well as those familiar with our general discipline. So within two articles we have an interest for engineers, those investigating the mind, the general hobbyist, teachers, parents, students in general and all school children now getting to grips with Information Technology, as it has to be taught in UK schools.

STEADY OUTPUT

It has been comforting through the year of recession in the UK to find that the interest in our hobby, and more particularly in *Everyday Electronics*, has not waned.

The dedicated team that produce EE each month, myself included, has a total of over 80 years of experience in the market place. Hopefully that does not mean we are a bunch of old fuddy-duddies (I certainly consider that I have a good few years left before I even think about considering myself to be "getting on a bit". If you know what I mean?). The point is that while we can bring a certain professionalism to the production of the magazine we also try to keep up to date and interest young new readers in our exciting and fascinating hobby.

As I have said before I am always interested in your views on the magazine and all your comments are read to assist me in forming the overall picture of your interests, likes and dislikes. Sometimes we change regular features – this month sees the last of the regular *Robot Roundup's*, mainly because the general interest in this subject has declined and most of the available product is expensive or aimed totally at teaching – in this way the magazine gradually changes to keep in step with the requirements of its readers.

So, next time you send for a back number, book, p.c.b., binder or subscription, if you want to add a one line comment to your letter please do. I assure you I will read it and – providing it's not too insulting – it will add to the mental picture of the ideal magazine forming in what's left of my grey matter.

Mike Kenward

SUBSCRIPTIONS

Annual subscriptions for delivery direct to any address in the UK: £18.50. Overseas: £23 (£40.50 airmail). Cheques or bank drafts **(in £ sterling only)** payable to Everyday Electronics and sent to EE Subscriptions Dept., 6 Church Street, Wimborne, Dorset BH21 1JH. Tel: 0202 881749. **Subscriptions start with the next available issue.** We accept Access (MasterCard) or Visa payments, minimum credit card order £5.

EVERYDAY
NOVEMBER 1991
ELECTRONICS
INCORPORATING ELECTRONICS MONTHLY
ELECTRONIC DARTS SCORER
BICYCLE ALARM
INFORMATION TECHNOLOGY
AND THE NATIONAL CURRICULUM
FOR PARENTS, STUDENTS AND TEACHERS

BACK ISSUES

Certain back issues of EVERYDAY ELECTRONICS are available price £1.80 (£2.30 overseas surface mail) inclusive of postage and packing per copy – **£ sterling only please**, Visa and Access (MasterCard) accepted, minimum credit card order £5. Enquiries with remittance, made payable to Everyday Electronics, should be sent to Post Sales Department, Everyday Electronics, 6 Church Street, Wimborne, Dorset BH21 1JH Tel: 0202 881749. In the event of non-availability **one** article can be photostatted for the same price. *Normally sent within seven days but please allow 28 days for delivery.* **We have sold out of Jan, Feb, Mar, Apr, June, Oct, & Dec. 88, Mar & May 89 & Mar 90.**

BINDERS

Binders to hold one volume (12 issues) are available from the above address for £5.95 (£6.95 to European countries and £9.00 to other countries, surface mail) inclusive of post and packing. *Normally sent within seven days but please allow 28 days for delivery.*

Payment in £ sterling only please. Visa and Access (MasterCard) accepted, minimum credit card order £5. Tel: 0202 881749

Editor: MIKE KENWARD

Secretary: PAMELA BROWN

Deputy Editor: DAVID BARRINGTON

Business Manager: DAVID J. LEAVER

Editorial: WIMBORNE (0202) 881749

Advertisement Manager:
PETER J. MEW, Frinton (0255) 850596

Classified Advertisements:
Wimborne (0202) 881749

READERS' ENQUIRIES

We are unable to offer any advice on the use, purchase, repair or modification of commercial equipment or the incorporation or modification of designs published in the magazine. We regret that we cannot provide data or answer queries on articles or projects that are more than five years old. Letters requiring a personal reply must be accompanied by a **stamped self-addressed envelope** or a **self addressed envelope and international reply coupons.**

All reasonable precautions are taken to ensure that the advice and data given to readers is reliable. We cannot however guarantee it and we cannot accept legal responsibility for it.

COMPONENT SUPPLIES

We do not supply electronic components or kits for building the projects featured, these can be supplied by advertisers.

We advise readers to check that all parts are still available before commencing any project in a back-dated issue.

We regret that **we cannot provide data or answer queries on projects that are more than five years old.**

ADVERTISEMENTS

Although the proprietors and staff of EVERYDAY ELECTRONICS take reasonable precautions to protect the interests of readers by ensuring as far as practicable that advertisements are *bona fide*, the magazine and its Publishers cannot give any undertakings in respect of statements or claims made by advertisers, whether these advertisements are printed as part of the magazine, or are in the form of inserts.

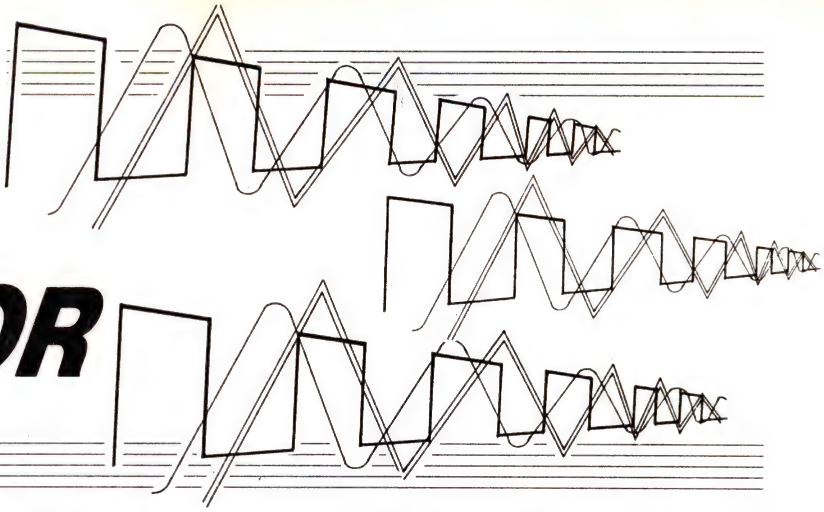
The Publishers regret that under no circumstances will the magazine accept liability for non-receipt of goods ordered, or for late delivery, or for faults in manufacture. Legal remedies are available in respect of some of these circumstances, and readers who have complaints should first address them to the advertiser.

TRANSMITTERS/BUGS/TELEPHONE EQUIPMENT

We would like to advise readers that certain items of radio transmitting and telephone equipment which may be advertised in our pages cannot be legally used in the U.K. Readers should check the law before using any transmitting or telephone equipment as a fine, confiscation of equipment and/or imprisonment can result from illegal use. The laws vary from country to country; overseas readers should check local laws.

Constructional Project

SIGNAL GENERATOR



STEVE KNIGHT

An easy to build test instrument that does not compromise on accuracy. 0.1Hz to 100kHz, better than 2 per cent.

A NUMBER of low-frequency signal generator circuits using the 8038 function chip have appeared in electronics magazines over the years. An examination of these designs have shown that most of them have been nothing more than producers of sine, square and triangular waveforms without any particular regard being addressed to the accuracy either of frequency or output voltage levels. It is true that for most measurements over the audio range, precise frequency is not all that important, but for work on such systems as filters it is.

Since it is as easy to build an instrument with good accuracy as it is to build one in which the accuracy is indifferent, then it is not something to be neglected. The same is generally true of output levels; in many projects a control is provided to turn the wick up and down, but what the actual output level is for any particular setting is a matter of guesswork or estimation.

Well, since the 8038 still seems to be going strong in the integrated circuit world, here is a design for a Signal Generator which enables quantitative measurements to be made over the frequency range 0·1Hz to 100kHz with an accuracy better than 2 per cent and an output level range from a maximum of 10V peak-to-peak to 40dB down on this in four switched ranges and a continuously variable control. The output impedance is 50 ohms.

There is a separate TTL compatible square wave output, and provision is made for an external modulating signal to be imposed on the generated frequency, this facility enabling audio-range response curves of amplifiers, filters and the like to be readily displayed on an oscilloscope. The whole assembly (apart from the simple power supply) is arranged on a single printed circuit board (p.c.b.) and when mounted in its case forms an attractive and useful instrument.

THE 8038

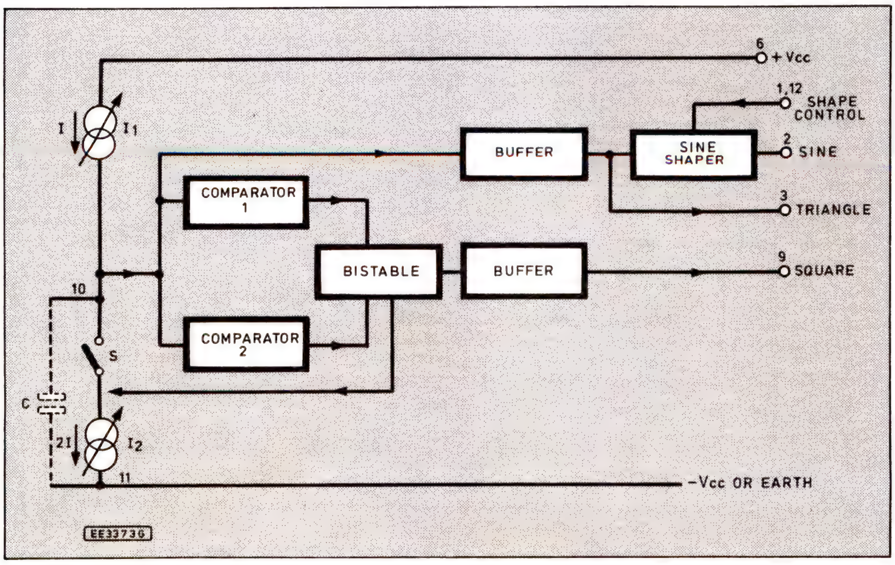
For those constructors who may not be familiar with the 8038 waveform generator chip (and there are newcomers arriving all the time these days), here are a few relevant details about what you get for your money.

The i.c. comes in 14-pin d.i.l. format and is fabricated with monolithic technology, using Schottky diodes and thin film resistors together with something like *fifty* transistors to provide signal outputs in sine, square and triangular waveshapes over a possible frequency range of 0.001Hz to something like 250kHz. A functional diagram is given in Fig. 1, where the system is seen to be made up from two comparators, two constant-current sources, two buffer amplifiers, a bistable switch and a triangular-to-sinewave approximation converter.

When an external capacitor C is connected, together with an appropriate power supply, V_{cc}, the comparators sense the charging and discharging voltage levels across C and respond to define a rising and falling ramp voltage held between two precise potential excursions. Comparator 1 responds to a voltage level of two-thirds V_{cc} while Comparator 2 responds to a level of one-third V_{cc}.

Suppose the capacitor C is to be charged by way of constant-current source I_1, current source I_2 being switched off at switch S. The voltage across C will rise linearly (since the current is constant) until it reaches a level equal to $^2/_3 V_{cc}$; Comparator 1 will then trigger and cause the bistable to change state. This closes electronic switch S and the capacitor begins to discharge through current source I_2, but now decreasing linearly with time.

Fig. 1. Function diagram of the 8038 generator i.c. The constant current generators are shown in the situation of a symmetrical output waveform.



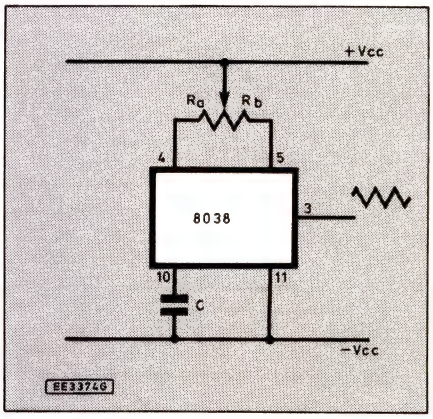
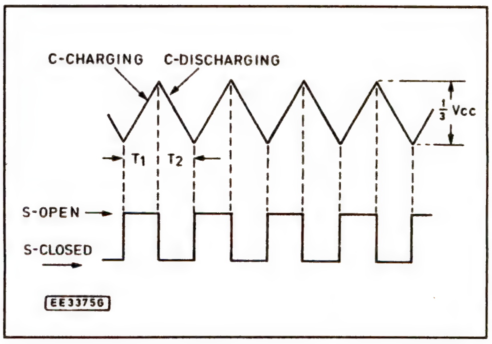


Fig. 2. Method of balancing the output triangular waveform.

Fig. 3. Relationships between the charging cycle and the bistable switching action.



When the capacitor voltage reaches the trigger level of Comparator 2, set at $\frac{1}{3}V_{cc}$, the bistable responds by reverting to its initial state, switch S opens, and the capacitor begins again to charge through current source I_1. This cycle of events then repeats indefinitely, with the amplitude of the triangular wave which appears across C being $\frac{1}{3}V_{cc}$ and of a frequency depending upon the value of C and the charge and discharge current levels.

BALANCED OUTPUT

These levels, and hence the frequency of the triangular wave, can be varied in a practical circuit by two external resistors connected between positive V_{cc} and pins 4 and 5 on the integrated circuit. Strictly, these resistors are best kept separate, but the arrangement shown in Fig. 2 simplifies the circuit and enables the effective resistance between the pins and the supply line to be adjusted over a sufficient range to make the charge and discharge gradients equal, that is, to achieve triangular symmetry.

Resistance R_a controls the rising portion of the charge on C and since the amplitude of the triangular wave is $\frac{1}{3}V_{cc}$ and as we have seen, the period of the rising portion is $T_1 = \frac{5}{3}CR_a$. See Fig. 3.

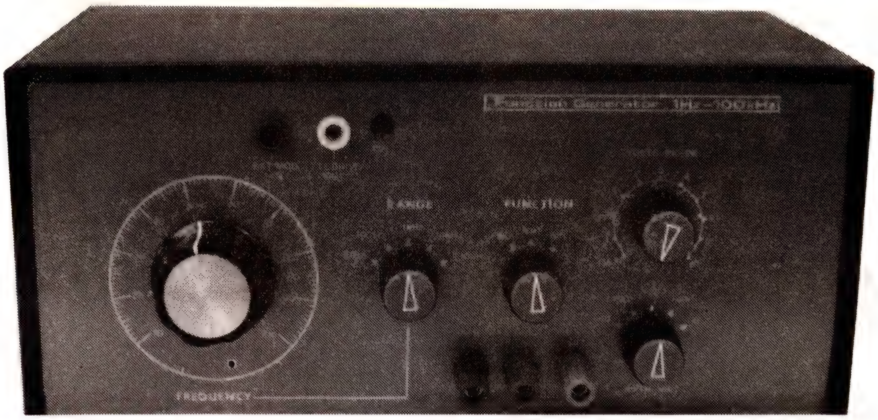
The falling portion of the wave is slightly more involved, its period is $T_2 = \frac{5}{3}(R_aR_bC)/(2R_a - R_b)$. From this we see that if $R_a = R_b$, T_1 will equal T_2 and the triangle will be symmetrical. This is the normal operating condition; the constant-current sources then have the relative levels shown in Fig. 1.

If R_a and R_b are not equal the charge time is not equal to the discharge time, and the triangular wave is asymmetrical, tending towards a sawtooth form as the resistors differ in value. It should be noticed that the supply voltage does not affect the switching actions; this is because both current sources and the comparators thresholds are direct linear functions of V_{cc}, hence the frequency is unaffected even though the supply voltage may vary.

The triangular waveform developed across capacitor C is passed through a buffer stage and is available at pin 3 of the package. The output of the bistable itself is, of course, a square wave, the change of state occurring in step with the changeover from charge to discharge of the capacitor, and conversely. Fig. 3 shows this relationship. After passing through a buffer stage, the square wave is available at pin 9.

The sinewave output is derived from the triangular wave and is shaped by a series of approximations within a non-linear circuit system made up from 16 transistors and graded resistors. A perfect sinewave cannot be produced by this method but by careful external adjustments which modify the characteristics of the shaping circuit, distortion can be reduced to less than 0.5 per cent at frequencies below 10kHz and within 2 per cent for frequencies up to 100kHz. The sinewave output appears at pin 2 of the integrated circuit.

As the sinewave is derived from the triangular wave, it will not be symmetrical unless the triangular wave is symmetrical; the same applies to the square wave. The mark-space ratio will only be 1 to 1 (or the duty cycle equal to 50 per cent) if the triangle is balanced. At the setting up stage, therefore, adjustment of the equivalent resistors R_a and R_b mentioned above must be made with extreme care.



COMPONENTS

Resistors

R1, R4, R18, R19	10k (4 off)	R15	100 1%
R2, R3, R5, R6	180k (4 off)	R16	33 1%
R7	1k	R17	10 1%
R8, R9	4k7 (2 off)	R20, R21, R22	10 (3 off)
R10, R12	5k1 (2 off)	R23, R27	3Ω9 (2 off)
R11	3k9	R24	51
R13	1k 1%	R25, R26	12k (2 off)
R14	300 1%	R28	3k3 1W
		R29, R30	47 1W (2 off)

All ½W 5% carbon, except where stated.

Potentiometers

VR1	4k7 multiturn preset
VR2	10k min. rotary Colvern CP1601, lin.
VR3, VR4	10k multiturn preset (2 off)
VR5, VR6	100k min. preset, horiz. (2 off)
VR7	2k2 min. preset, horiz.
VR8	10k min. preset, vert.
VR9	4k7 min. preset, horiz.
VR10	1k min. rotary carbon (type P20) lin., with d.p. switch

Capacitors

C1	100n polyester
C2	4700p polyester 1%
C3	100p silvered mica or polystyrene
C4	330p silvered mica or polystyrene
C5, C14	0µ22 polyester
C6	8200p polystyrene 1%
C7	39000p polystyrene 1%
C8	0µ47 5% or selected
C9	4µ7 (selected)
C10	10n polyester
C11, C12	100µ radial elec. 25V
C13	10p min. ceramic
C15, C16	1000µ axial elec. 25V

Minimum 5% except elects. and where stated

See SHOP TALK Page

Semiconductors

D1, D2, D7 to D10	1N4148 signal diode (6 off)
D3	OA90 germanium signal diode
D13	5mm red l.e.d.
D4	4V3, 400mW Zener diode
D5, D6	2V4, 400mW Zener (2 off)
D11, D12	13V, 1.3W Zener (2 off)
TR1, TR5	BC549 *npn* silicon transistor (2 off)
TR2, TR6	BC559 *pnp* silicon transistor (2 off)
TR3	BC107 *npn* a.f. driver transistor
TR4	BC177 *pnp* a.f. amp. transistor
IC1	741 op. amp
IC2	8038 waveform generator
IC3	741S op. amp
REC1	W005 1.5A 50V bridge rectifier

Miscellaneous

S1 to S3	2-pole 6-way rotary switch, with adjustable limit stop (Lorlin) (3 off)
S4	d.p.s.t. switch, part of VR10
T1	Min. mains transformer, 12V-0V-12V 250mA sec.
FS1	500mA 20mm fuse and holder

Aluminium, vinyl-covered, case, size 305mm x 130mm x 160mm; 8-pin d.i.l. low-profile socket (2 off); 14-pin d.i.l. low-profile socket; 4mm terminals, one each red, blue, green; 4mm socket, one each brown, white; control knobs 1mm dia. (4 off), 45mm dia. (1 off); solder pins; 3-core mains cable; rubber grommet, ¼in. inside dia. (2 off); connecting wire; solder etc.

Printed circuit boards available from the *EE PCB Service*, codes EE776 (Sig Gen) and EE777 (PSU)

Approx cost guidance only **£45**

CIRCUIT DESCRIPTION

The full circuit diagram of the Signal Generator is shown in Fig. 4, with a suitable power supply unit in Fig. 5. This last unit is a conventional dual voltage arrangement and both positive and negative rails are stabilized by 13V Zener diodes, D11 and D12 respectively, mounted on the main board.

The choice of 13V rails may seem an odd value (no pun intended) but the 8038, although designed to be used up to a 15V-0V-15V dual or a single 30V supply (some references say 36V), does tend to run, in my experience, rather hot when operated at these limits. As the frequency is temperature dependent, it seems best to avoid as much heating as possible, consistent with being able to generate an output to the design level of 10V peak-to-peak. The quoted frequency drift for the standard chip is typically 50ppm°C with an upper operating temperature of 70°C.

Using a 13V-0V-13V supply, any possibility of the device overheating seems to be avoided, particularly when the circuit may be switched on over an extended period. Nothing more elaborate than this simple Zener stabilization is necessary to achieve this.

FREQUENCY OUTPUT

The frequency output from the 8038 is determined by the capacitance connected between pin 10 and the negative rail and by the voltage on pin 8. The voltage across the resistance chain VR1, VR2, VR3 and R1 is 13V; taking the presets VR1 and VR3 to be approximately at the centre of their tracks when the required frequency range is covered by the main panel control VR2.

The potential excursion swept out by potentiometer VR2 is about 12.5V to 7.5V; in conjunction with the appropriate value of capacitor, this enables a 10:1 frequency sweep to be obtained. This enables the frequency ranges covered to go up in conventional decade steps by a choice of capacitors which go up in the same ratio. The capacitors, two of which are made up from parallelled arrangements, are selected by the front panel rotary switch S1.

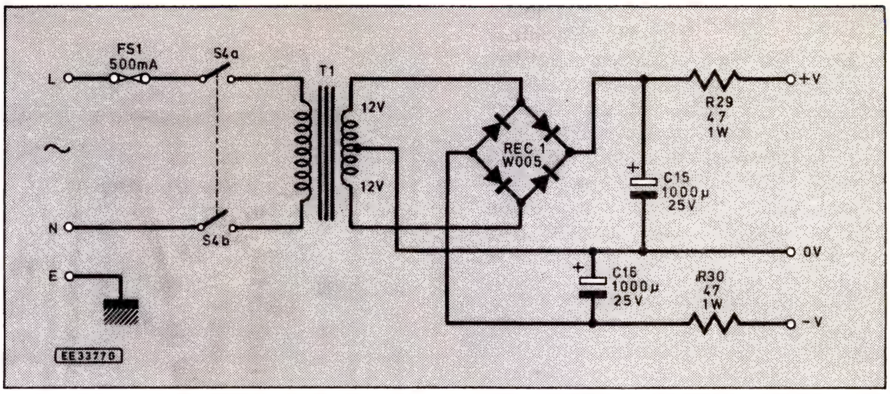


Fig. 5. Circuit diagram of the Power Supply Unit. Switch S4 is part of potentiometer control VR10.

In most designs, the slider of frequency control potentiometer VR2 is connected directly to pin 8. This is quite permissible, but by using a unity gain op.amp, IC1, between the control and the 8038, provision is made for frequency modulation from an external source (SK1). This will be considered later on in more detail.

The output of IC1 (pin 6) follows the voltage present on its non-inverting input, hence pin 8 of the 8038 receives the voltage variation from VR2. The output frequency of IC2 produced at pins 2, 3 and 9 is directly proportional to the voltage on pin 8, hence potentiometer VR2 is selected with a linear track, so making the panel frequency scaling linear with rotation also.

Pin 8 of IC2 is susceptible to pick-up, so capacitor C1 bypasses any such unwanted transients to "ground". Diode D1 in the supply feed to the 8038 is included to prevent distortion which can occur when the slider of VR2 is close to the V_{cc} voltage.

WAVEFORMS

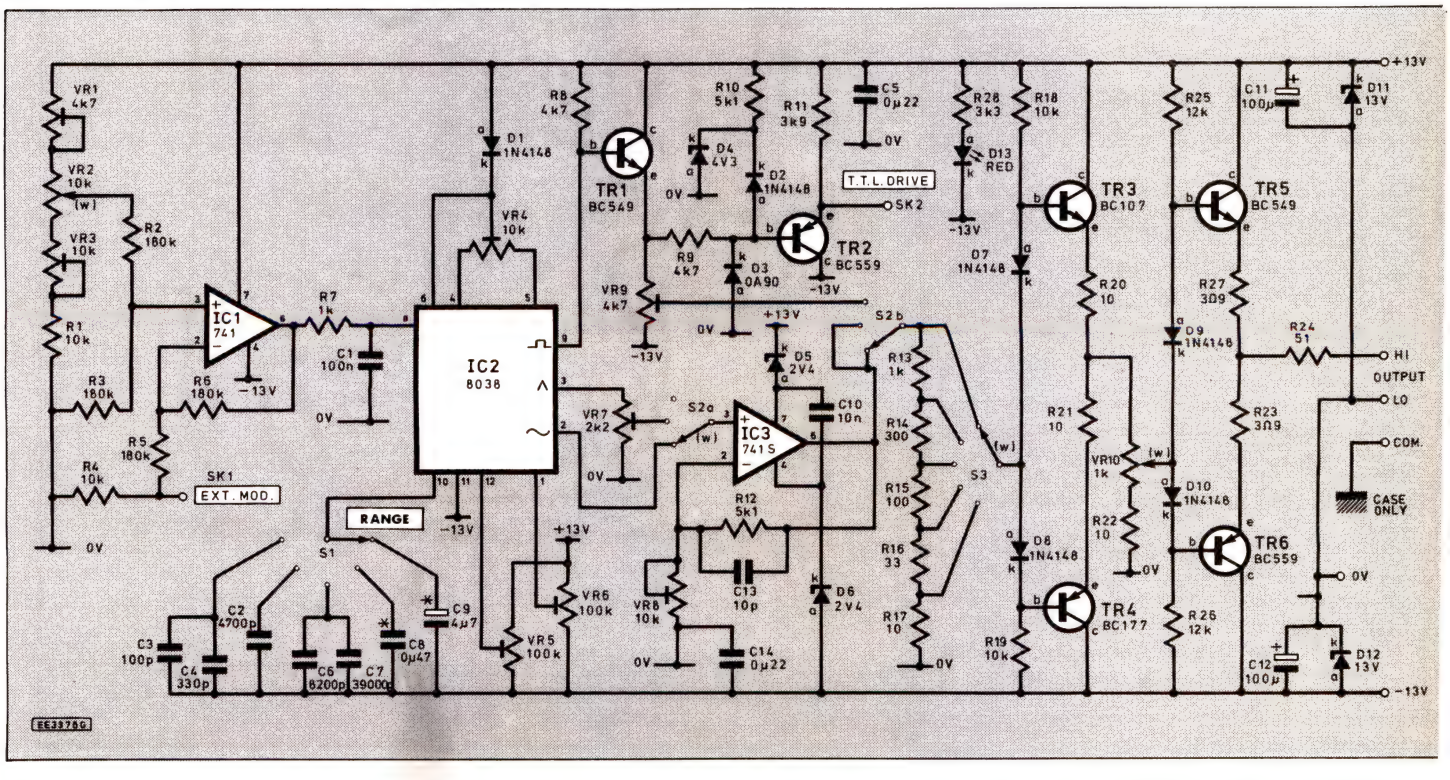
The three waveforms available at pins 2, 3 and 9 of IC2 could be used directly as outputs, but there are reasons why this is not a practical proposition. To begin with, the outputs are all at different amplitudes; the square wave on pin 9 has a peak-to-peak amplitude which is not far short of the supply voltage; the triangular wave has, as we have noted, an amplitude of one third V_{cc}, and the sinewave output has an amplitude of only about 0·22 of the supply voltage. So something has to be done to balance things up a bit.

Further, the 8038 can be damaged if the output pins are shorted out or if excessive current is drawn. There is no internal protection which will limit the output currents, so it is necessary to ensure that the generator outputs operate into circuits with high input impedances.

This can be accomplished best by feeding into an op.amp or an emitter-follower. In this circuit, both methods are employed.

The sinewave output (pin 2) of about $0{\cdot}22V_{cc}$ (about 6V peak-to-peak) feeds directly (via Function selector switch S2a) into the non-inverting input of IC3, as does the triangular wave output (pin 3), this

Fig. 4. Circuit diagram for the Signal Generator. It is important that potentiometer VR2 has a wide rotation angle (300°) for good frequency spread.



being suitably reduced by the preset potentiometer VR7 to equalize its amplitude with that of the sinewave. The gain of IC3 is then set by adjustment of the feedback preset resistor VR8 for the output to be precisely 10V peak-to-peak at switch S2b.

In the meanwhile, the square wave output at pin 9 on IC2 bypasses the op.amp and feeds instead into transistor TR1, an emitter-follower, the output at the emitter being adjusted by preset VR9 to match the 10V peak-to-peak amplitudes of the sine and triangular waves at switch S2b. In this way, switches S2a and S2b being ganged, all waveform levels are identical at the wiper (w) or pole contact of S2b, and the necessary high impedance loading on the generator outputs is achieved.

TTL OUTPUT

To provide a useful TTL compatible output of a 5V amplitude square wave independent of the other outputs selected by switch S2b, the square wave appearing at the emitter of TR1 is passed at full amplitude into the base of the second emitter-follower TR2, this time a *pnp* transistor. Zener diode D4, however, holds the potential at the junction of resistor R10 and diode D2 at 4.3V.

The positive excursion of the square wave cannot therefore exceed 5V, the drop across D2 being about 0.7V when it is driven into conduction; and the negative excursion is held at close to earth potential by the conduction of diode D3. A 5V amplitude square wave consequently appears at the emitter of TR2. This is taken to a separate terminal on the front panel of the instrument as a TTL Drive Output signal.

The switched attenuator made up from resistors R13 to R17 is a coarse control giving voltage ratios of 1, 0.3, 0.1, 0.03 and 0.01 very closely corresponding to attenuations of 0dB, −10dB, −20dB, −30dB and −40dB respectively below 10V peak-to-peak. The output voltage ranges on potentiometer VR10 which is the fine attenuator control, are therefore 0-10V, 0-3.16V, 0-1V, 0-31mV and 0-100mV. The use of a peak-to-peak calibration provides easy correlation between sine and the other output waveforms.

The output and intermediate driver amplifiers are quite conventional complementary stages, having an overall unity gain. TR3 is a BC107 and TR4 its complement, the BC177. TR5 and TR6 are complementary pairs BC549 and BC559 respectively. The output is taken via resistor R24 and has a nominal impedance of 50 ohms.

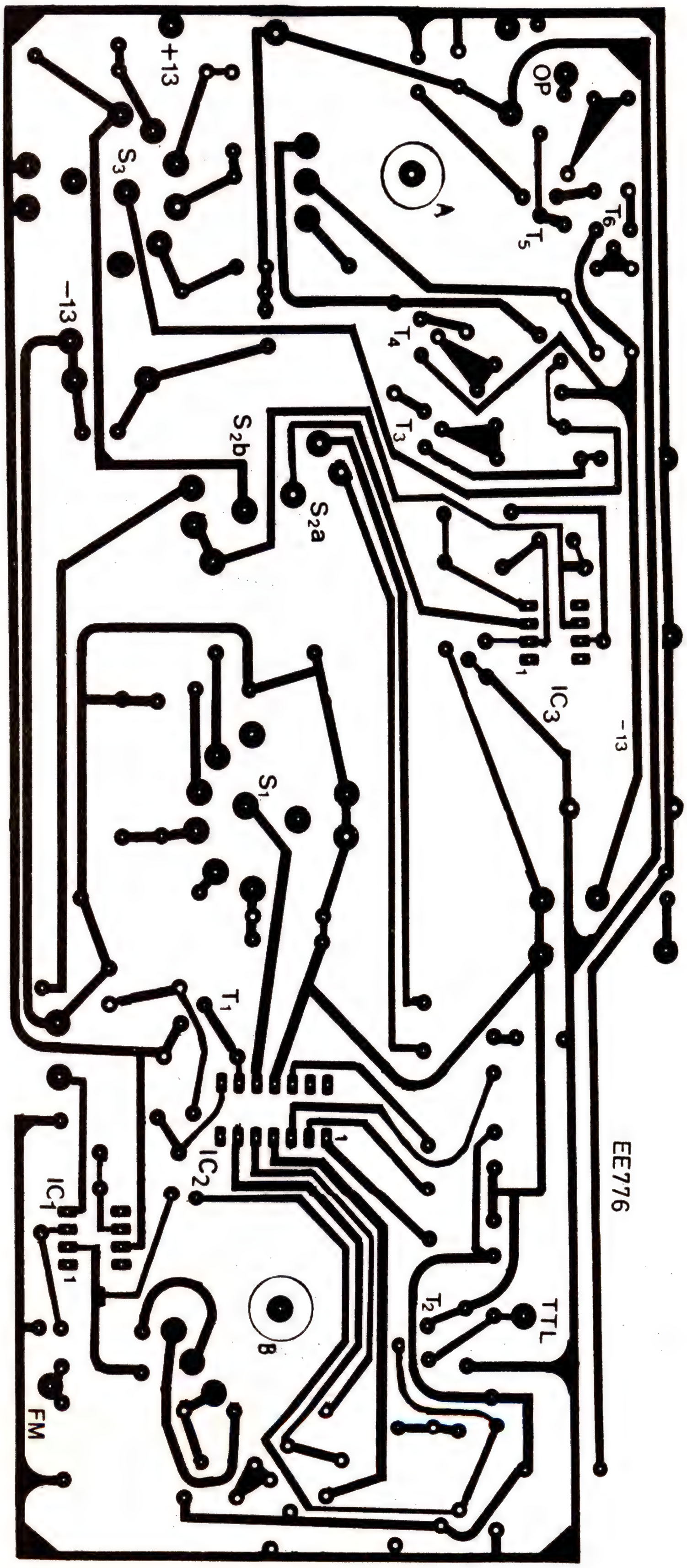
A l.e.d. indicator is provided, D13, which is fed from the full dual supply rails by way of limiting resistor R28.

Little need be said about the power unit, Fig. 5, which is assembled on a small separate p.c.b. A 12V-0V-12V, 250mA miniature mains transformer feeds into a bridge rectifier, REC1, which provides both positive and negative outputs of about 18V (unloaded) about the 0V line taken from the transformer secondary centre-tap.

Smoothing is carried out by 1000µ 25V working capacitors C15 and C16. Two 47 ohm one watt resistors R29, R30 act as safety limiters for the 13V Zener stabilizers D11, D12 on the main board.

CONSTRUCTION

Construction of this project is basically very easy as all components are mounted



Full size underside copper foil master pattern. The connecting pads for potentiometers VR2 and VR10 are not drilled.

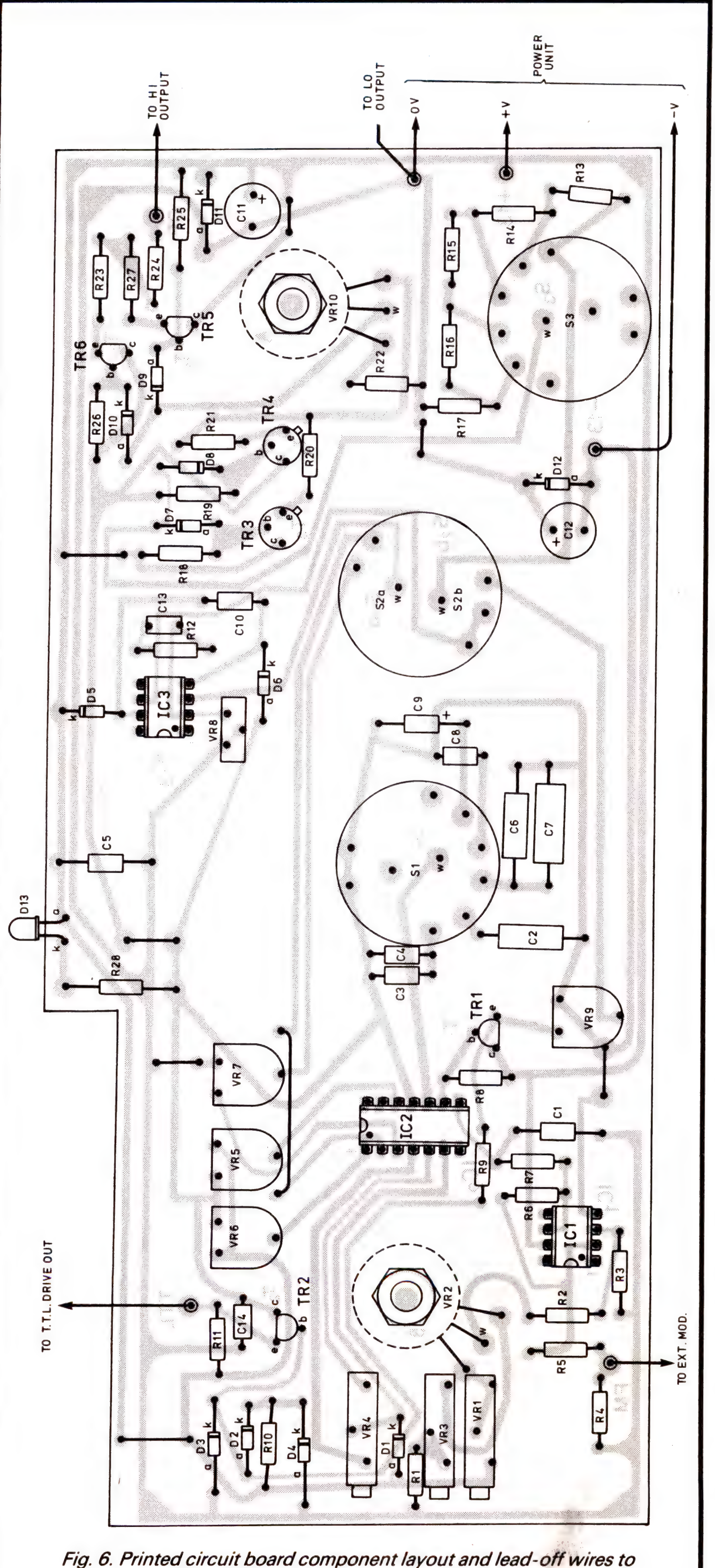

TO HI OUTPUT
TO LO OUTPUT
POWER UNIT
0V
+V
-V
TO T.T.L. DRIVE OUT
TO EXT. MOD.
R1 R2 R3 R4 R5 R6 R7 R8 R9 R10 R11 R12 R13 R14 R15 R16 R17 R18 R19 R20 R21 R22 R23 R24 R25 R26 R27 R28
C1 C2 C3 C4 C5 C6 C7 C8 C9 C10 C11 C12 C13 C14
D1 D2 D3 D4 D5 D6 D7 D8 D9 D10 D11 D12 D13
TR1 TR2 TR3 TR4 TR5 TR6
IC1 IC2 IC3
VR1 VR2 VR3 VR4 VR5 VR6 VR7 VR8 VR9 VR10
S1 S2a S2b S3
w
a
k
b
c
e

Fig. 6. Printed circuit board component layout and lead-off wires to front panel sockets and power supply board. Indicator l.e.d. D13 is fitted after assembly to the panel.

on two p.c.b's. The component layouts are shown in Fig. 6 and Fig. 10. These boards are available from the *EE PCB Service* codes, EE776 (Sig. Gen.) and EE777 (PSU).

The only separate wiring runs to external parts are those to the various output terminals (four wires), those between the power unit and the main board (three wires), and the mains supply input which goes via fuse FS1 and on-off switch S4 (on the fine attenuation control VR10) to the transformer primary.

The main board fits directly on to the front panel, the three switches bush nuts being the means by which attachment is made. It is necessary then for the panel drilling to match *exactly* to the control component spindles and bushes on the board and we will return to this later on.

CIRCUIT BOARD

The component layout and full size printed circuit copper foil master pattern of the main signal generator board is given in Fig. 6. If you make your own, it is essential that the hole positions for the Frequency control potentiometer VR2 and the fine output attenuator VR10 (shown at points *B* and *A* respectively) are precisely drilled in the positions indicated.

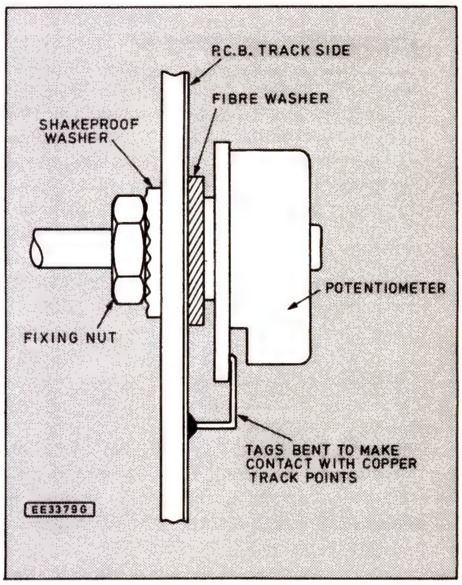


Fig. 7. How the attenuator potentiometer VR10 is fitted to the p.c.b.

These pots are mounted on the track side of the board and the tags of VR10 are bent forward through 90 degrees to make solderable contact with the three copper pads provided for each of them, see Fig. 7. Potentiometer VR2 has a wide electrical rotation angle and must be the type specified if an adequate sweep is to be obtained for each frequency range. This pot is wired with short length of wire from its tags down to the pads on the printed board. It is also necessary to ensure that the switch contact connecting pads on the board are drilled accurately as the switch positions must also coincide with the panel drilling holes.

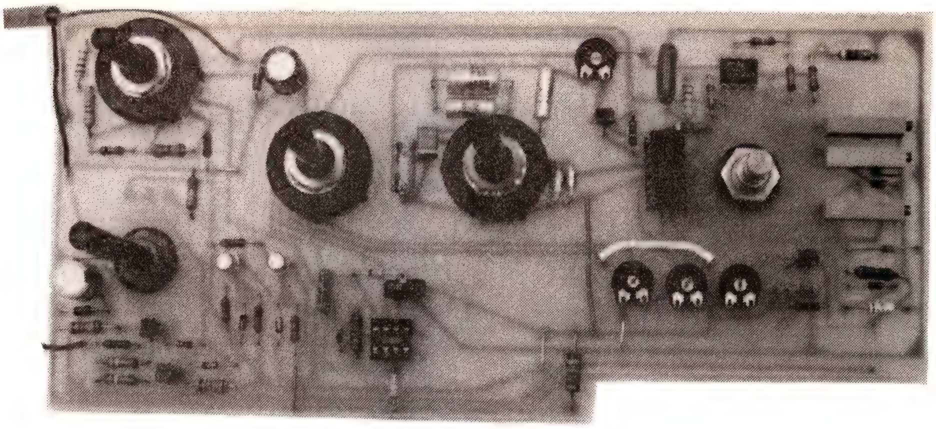
A 1mm drill is suitable for all the component mounting holes except those which are for the miniature preset potentiometers VR5, VR6, VR7 and VR9. These require a 1.2mm drill.

The switches S1, S2 and S3 are mounted directly onto the board and their connecting pads need to be drilled 1.6mm (1/16 inch), through a hole up to 2mm is acceptable. The preset VR1, VR3 and VR4 are multi-turn types requiring only a 1mm drilling.

The order of assembling components on the board is not particularly important; it is perhaps best to begin with the various jumper links (there are eight of these), then all the diodes (taking care with the polarities), then the resistors and capacitors, presets and transistors. Make sure with the transistors that you don't muddle the *npn's* with the *pnp's*.

It is probably advisable to use low-profile i.c. holders for the three integrated circuits just in case you get a dud (not unheard of), but if you are an optimist they may be soldered directly to the board. IC3 *must* be a 741S, not a plain 741, though this latter type is suitable for IC1.

The control potentiometers and the three switches are best left to last as their projecting shafts can prove a hinderance if they are mounted sooner. The two potentiometers VR2 and VR10 which go on the track side of the board must have a *thin* fibre or other type of insulating washer between the case and the board as Fig. 7 illustrates; this ensures that there is no possibility of the metal case touching onto the board tracks.


The completed printed circuit board showing component layout. Note that potentiometers VR2 and VR10 are mounted on the track side.

FREQUENCY CAPACITORS

Just a word at this point about the frequency selector capacitor associated with the rotary switch S1. Capacitors C3 and C4 are 330pF and 100pF one per cent silvered mica (or polystyrene will do) connected in *parallel* to give a total of 430pF for the 100kHz range. In theory a 470pF is needed but there are sufficient strays to make 430pF adequate.

Capacitor C2 is a 4700pF one per cent capacitor, and C6 and C7 are 39000pF and 8200pF one per cent capacitors in parallel to give a close 47000pF. It is necessary for the capacitors to be as accurate as possible, and by using one per cent precision types and combining them where necessary, very accurate frequency scaling is obtained throughout the ranges 1kHz to 100kHz.

It is not so easy to obtain a one per cent capacitor of the value required for C8, but nothing worse than five per cent should be selected. The 4.7µF electrolytic, C9, is just that, though you may be able to get a five per cent polycarbonate type (rather pricey though!) or make up a combination from, say two 2.2µF plus a 330nF. If you have access to a capacitance meter or bridge use it as I did, to select these larger value capacitors.

SWITCHES

The three Lorlin rotary switches need a bit of work done on them preparatory to mounting on the board. Not all of the pins are used and certain of them have to be snipped off. Also, the position of the locating stop-ring has to be adjusted. Fig. 8 shows how this is done.

First, turn each switch fully *anticlockwise*. For S1 and S3 the stop-ring should then be moved back one place to position 5; this makes the switches 5-way types. For S2 put the stop back to position 3; this then makes this a 3-way type. Replace the washer and nut and *check* that the switches all move the appropriate number of places from the anticlockwise position.

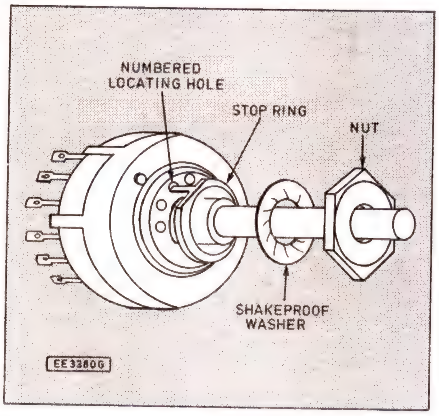


Fig. 8. How to adjust the number of "ways" on the rotary switches.

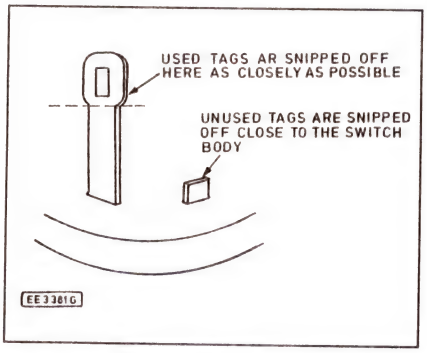

USED TAGS AR SNIPPED OFF HERE AS CLOSELY AS POSSIBLE
UNUSED TAGS ARE SNIPPED OFF CLOSE TO THE SWITCH BODY
EE3381G

Fig. 9. Preparing the rotary switches for the p.c.b. by snipping the tags as indicated in the text.

The following table indicates which of the switch tags have to be snipped off completely. Snip them off close to the body of the switch to leave stumps not more than about 1mm high. Fig. 9 shows the method.

Switch S1: remove tags 6, 7, 10, 11
Switch S2: remove tags 4, 5, 6, 7, 10, 11, 12
Switch S3: remove tags 1, 4, 5, 12

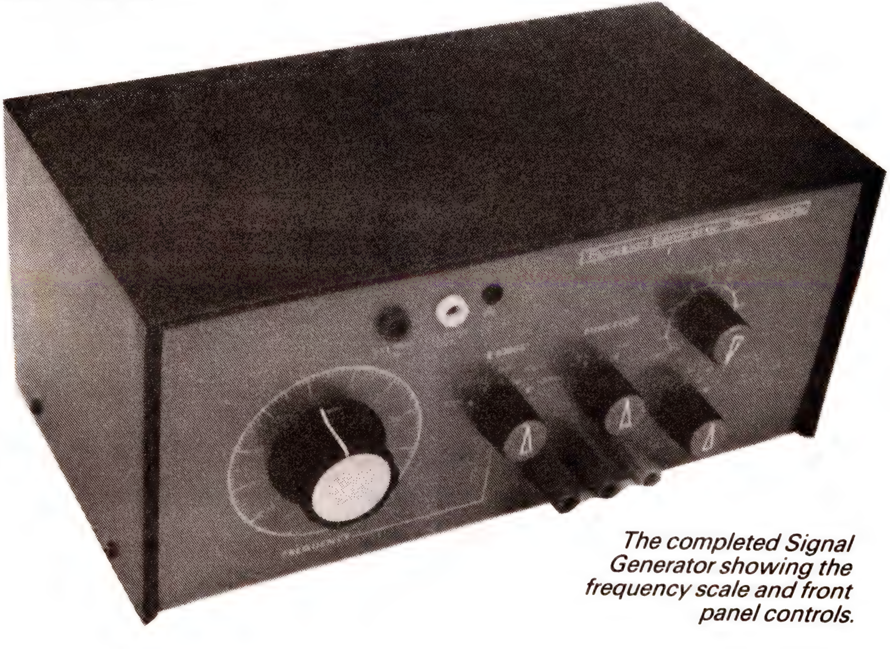
All the remaining tags then have their eyelets *only* removed as Fig. 9 indicates, leaving as much of the tag as possible on these so that they will protrude on the track side of the board by about 1mm when fitted. This enables a sound soldered connection to be made to the copper foil.

Using your snips "upside down" for this job is advantageous in that it enable the eyelet to be removed without biting into the stump itself. The orientation of the flat on the switch shafts will be automatically correct for the fitting of a grub-screwed knob (if you prefer these) when finally assembled.

MOUNTING THE SWITCHES

When mounting the switches on the board, made sure the tag stumps are not bent out of vertical and that their tops haven't been "sprayed" out by your snipping action. Push them into their respective hole positions carefully, making sure that the board is not bent or strained.

It is best, once the pins are located in their holes, to lay the board flat on a soft


The completed Signal Generator showing the frequency scale and front panel controls.

but firm surface and press the switch home by applying firm pressure to the body of the switch. This will ensure that the switch sits squarely on the board *before* soldering; unless you check this point the shaft may not be at right-angles to the plane of the board and it will not locate through the appropriate panel hole later on.

Also, on the front face of the switches there is a small locating boss formed in the plastic; this should be snipped off as well as this is not required for locating purposes. Do not fit the l.e.d. D13 indicator at this stage.

POWER SUPPLY

The printed circuit board component layout and full size copper foil master pattern for the Power Supply Unit (PSU) is given in Fig. 10. The two separate secondary windings of the mains transformer are connected together at the two centre tags and this centre-tap point together with the outer connections are wired through to the board foil with short lengths of bare wire.

Take particular care when fitting the bridge rectifier; this can go in any one of four ways since the lead spacing is symmetrical, and only one is correct! Also, make sure the electrolytics are correctly polarized.

Later on, the fitting of the supply board to the instrument case is accomplished by screws and spacers through the two transformer fixing points marked *F* (so use temporary screws to secure the transformer at this stage) and the hole marked *G* between the + and − output points. Solder three solder pins to the three output points so that a convenient connection can be made to the main board during preliminary testing. The rest of the circuit and its assembly needs no further comment.

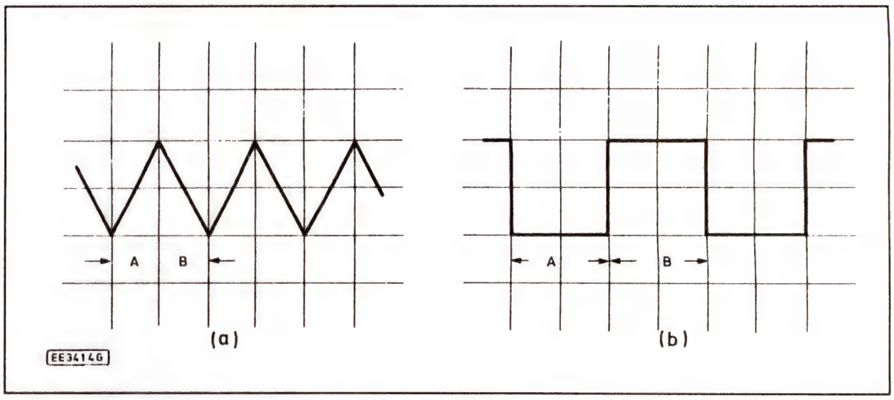


Fig. 11. Balancing the output signal by making the periods A and B equal. Either triangular or square waves may be used.

TEST AND ALIGNMENT

Nearly all of the testing and setting up of voltage levels can be done with the boards on the bench; all that remains once the boards are fitted into the case is the alignment of the main frequency scale. An oscilloscope is necessary for setting waveforms; the other requirements are an a.c. voltmeter and some means of measuring frequency. The oscilloscope does not need to be a particularly good one provided its Y-amplifier is distortion free up to 100kHz and its time-base is linear.

Using about 305mm (12 in.) lengths of wire for the time being, connect the main board to the power unit; also connect a short length of wire to the signal output point (from resistor R24) on the main board so that the output is available. Two insulated mains rated wires are also needed from the transformer primary terminals to the mains supply. It is wise to protect these terminals with a piece of insulating tape while setting up to avoid accidental contact.

Before applying power, turn all the preset potentiometers including the multiturns, to about their mid-positions. Turn the mains Frequency control pot VR2 to about its mid-position also, set the Range switch (S1) to the 1kHz mode (its middle position), the Function switch (S2) to Sine (fully clockwise), the Coarse Attenuator (S3) to 0dB (fully clockwise) and the Fine Attenuator pot (VR10) to maximum.

WAVEFORMS

Connect the oscilloscope input between the output point from R24 and earth (the Common connection). Switch on; a sinewave, probably distorted somewhat, should appear on the screen. Check briefly, using the Function switch, that a triangle and square wave are also present.

Turn the main Frequency control and verify that the frequency of the sinewave varies. Don't worry at this stage about either their actual shapes or their different amplitudes. Set the scope controls so that you get about three full cycles on the screen.

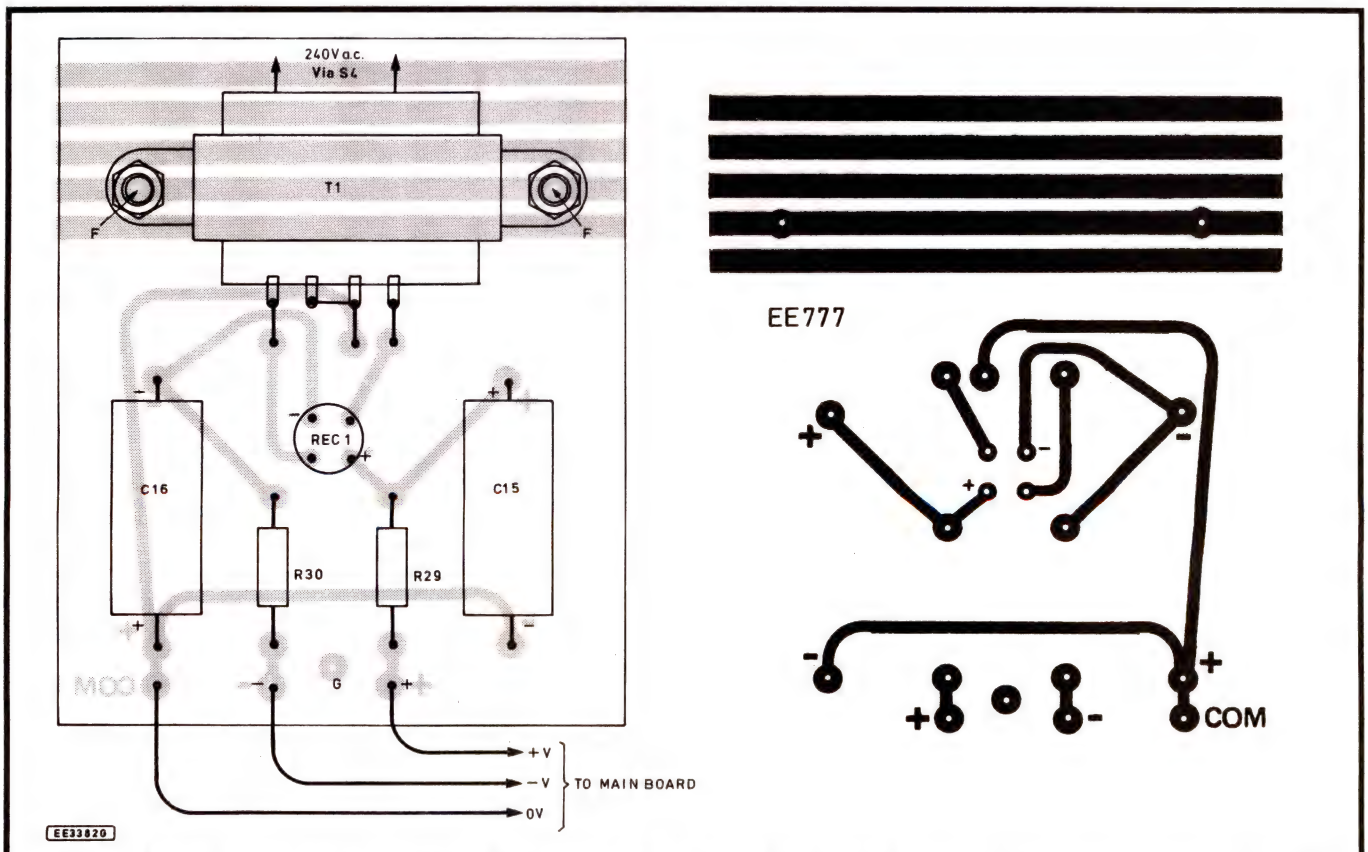


Fig. 10. Printed circuit board component layout and full size copper foil master pattern. Fixing holes at F and G are 6BA clearance, transformer T1 is temporarily fitted during assembly by two 6BA screws.

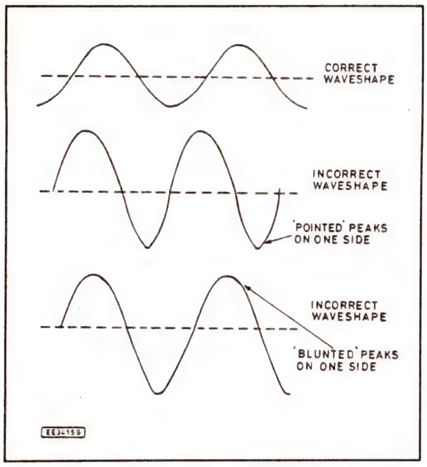


Fig. 12. using VR5 and VR6 adjust for best possible sinewave shape.

We now need to set the balance control VR4 to give us a symmetrical triangular wave. Set the Function switch to Triangle (fully anticlockwise) and adjust VR4 until the triangle on the scope screen is symmetrical, see Fig. 11a. It is sometimes easier to use the square wave for this adjustment; if you choose this, adjust VR4 until the square wave has a 1:1 mark-space ratio, see Fig. 11.

When you have got this right, switch back to Sine, and making sure that the Fine output attenuator pot is fully clockwise, adjust the gain preset VR8 (close to IC3) so that the output level is 10V peak-to-peak sinewave.

Now adjust VR5 and VR6 alternately to give the best sinewave shape you can get. This is a subjective matter and the thing to aim for is to get a sinewave that is equally "rounded" at the maximum and minimum points of each cycle, the rights and wrongs being illustrated in Fig. 12.

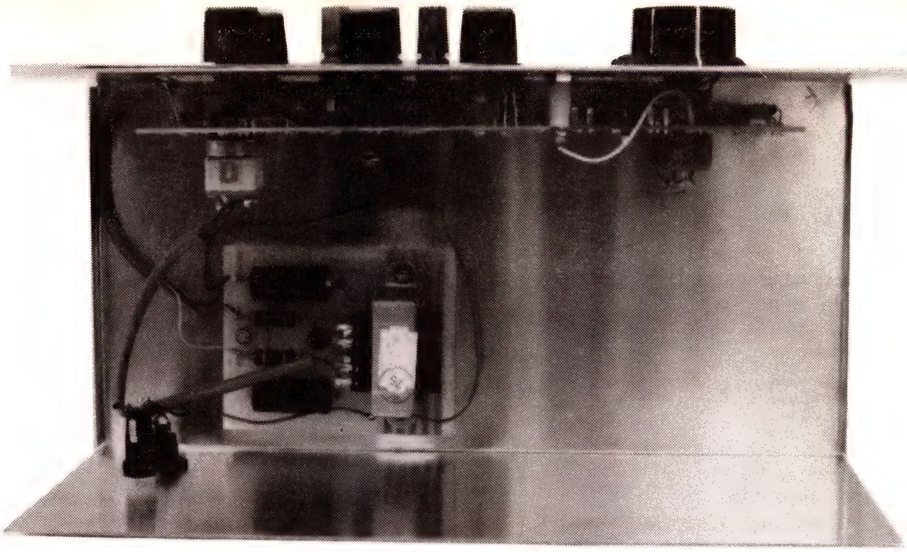
Ideally, a distortion meter should be used for the best possible waveform, but with care a very accurate sinewave can be obtained. Recheck now on the output level, as this may have changed slightly with the sinewave shaping adjustment.

For the correct amplitudes of the other two waveforms, the scope can again be used but if its accuracy is suspect, use the a.c. voltmeter again across the output points. Set the triangular amplitude using VR7 so that the meter reads 2.9V, this will be close enough, and for the square wave (where r.m.s. and peak vales are identical), adjust VR9 to give a reading of 5V. These measurements are best made at a relatively low frequency, say, somewhere on the 1kHz range or lower as an a.c. meter is strictly scaled for 50Hz, though most meters will be O.K. up to several kilohertz without error.

PREPARING THE CASE

The specified case measures 305 mm by 130mm high by 160mm deep and is a relatively inexpensive box having a vinyl covering over a plain aluminium lower part. For a reasonable finish, this lower part should be sprayed with a colour of your fancy, though the front panel itself will depend upon what you do about adding on a legended overlay. But more of this in a little while.

Apart from two holes to be drilled in the rear for the mains input lead and the fuse fitting, the positions of which are not critical, the front panel *must* have its holes drilled exactly suited to the positions indicated on the panel layout given in Fig. 13. Unless this is done, the board will not fit the panel drillings. You can achieve good results by marking through the holes on the unpopulated p.c.b.



Position and wiring of the two circuit boards inside the metal case.

If you are a dab hand with rub-down lettering, you can use Fig. 13 has a guide to make a good copy onto a piece of card or very thin aluminium. Alternately, you can get a twice up photocopy made on to a sheet of good quality paper of a colour of your choice, and stick this onto a piece of aluminium sheet. A full size frequency scale is shown in Fig. 14.

DRILLING

Whatever you decide, position the panel over the front of the case and mark through the hole centres onto the aluminium with a punch or scriber. Preferably drill small guide holes, say one-eighth inch, through the points you have marked and *recheck* their positions *before* going on to the full size drilling.

Now drill or punch out the positions to the following sizes: (a) the main frequency scale and the fine attenuator scale, 3/8 in. dia.; (b) the three switch positions, 3/8 in. dia., though it eases any slight inaccuracies if you make these 7/16 in. dia.; (c) the three lower level output terminals, 9/32 in. dia.; (d) the Ext Mod and TTL Drive positions, 5/16 in. dia.; (e) the l.e.d. "ON" position, 1/4 in. dia. If you use a drill, de-burr all the holes carefully.

You will need to file a very small V-shape at the base of each of the three output terminal holes to accommodate the locating lug on each of these terminals. The drillings mentioned under (c) and (d) above assume you use the specified terminals; if you do not, you must make these holes to suit your terminal choice.

ASSEMBLY

The front panel print can be either glued to the panel, if it is a paper photocopy, or held in position by the three switch locking nuts and the various terminals if a printed card is used. Put grommets with a 1/4 in. centre hole into the Frequency and Fine Attenuator holes so that the shafts of these two controls can pass through them when the board is offered up to the panel, using the grommets as soft bearings.

It makes things easier to push the shafts through the grommets if you smear a trace of caster oil inside the grommet holes. Check that the board control shafts pass correctly through the panel holes but do not fasten anything yet.

The power supply board is screwed to the base of the case by three fixing screws (6BA or 3mm metric will do) and held off the case floor by 1/4 in. spacers. Its position is not critical but it should be mounted about 1/4 in. from the rear of the case towards the end where the three power input leads come from the main board. The mains input point and fuse can then also be positioned at this end.

Before fitting the main (Sig. Gen.) board,

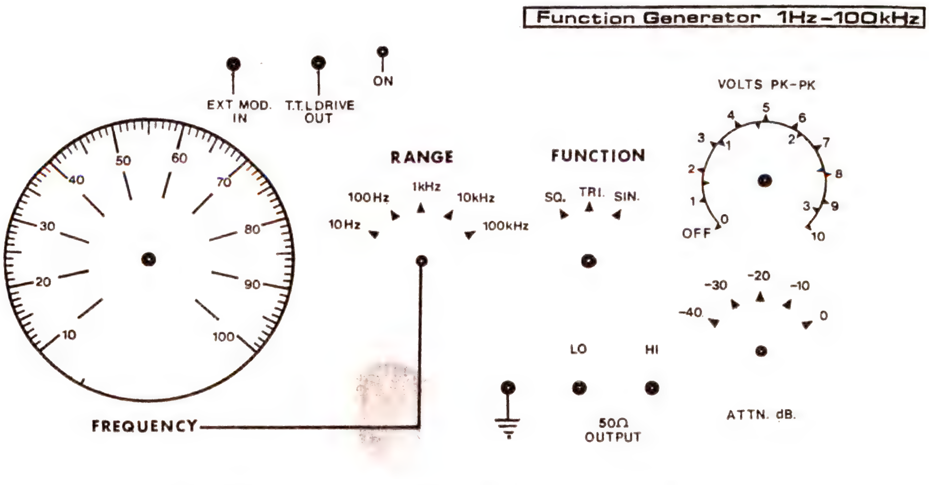


Fig. 13. Half-size details of front panel layout and frequency scale.

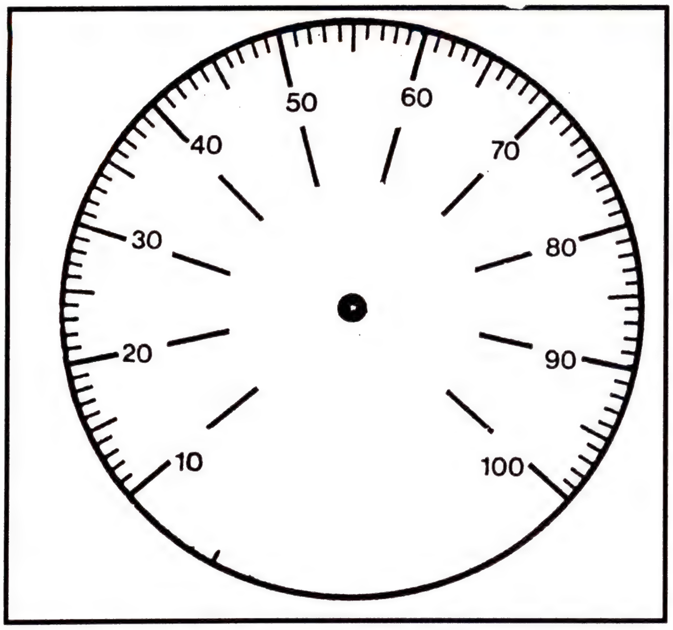


Fig. 14. Full size frequency scale.

solder lengths of flexible wire to the Ext Mod point (152mm), the TTL Drive point (76mm), and position these wires so that they can be connected to the two upper socket outlets *after* the board is mounted. Also, cut the three wires which will go to the power unit to about 7 in. in length.

It eases things if you solder the output wires (from R24) to the HI terminals, and 152mm lengths of wire to the other two terminals before fitting the board to the front panel. The "earth" one of these wires then goes to the case itself via a tag under one of the transformer fixing screws. The LO output does *NOT* go to the case but to the 0V connection pin on the power board where it also joins to the 0V lead from the main board.

To mount the main board, remove the three locking nuts from the three switches, taking care that the locating rings and the shakeproof washers do not fall out of position as you manoeuvre the board up to the panel and get the shafts into their respective holes. Push the board into position, letting the threaded bushes of the three switches fit snugly through their holes before putting their nuts back onto them. The shakeproofs are left *behind* the panel.

Tighten the nuts (but not overtight) and ensure that the board is straight and parallel to the panel and that nothing has been forced into position against its will. If there are slight inaccuracies in the bush positions, a touch with a file should remedy things, but this won't help if there are gross misalignments.

Once everything is shipshape, cut off the shafts to suit the knobs you are using. One-inch diameter collet knobs with marker caps are best; grub-screwed knobs must have their indicating marks opposite the screw positions. The main frequency control knob is a 45mm diameter component and should be fitted so that it moves over its rotation range equally beyond the extremities of the panel scale when turned fully in either direction.

The l.e.d. indicator D13 can now be fitted. bend its leads slightly so that they will pass through the two holes in the board, then bring the l.e.d. forwards so that it will slide into either a standard mounting clip of a ¼ in. inside-hole grommet mounted in the panel hole.

To complete things, the wiring from the mains input leads (three-core) and the fuse can now be taken via the double-pole switch on VR10 to the primary terminals of the transformer. If you have a split primary, don't forget to link the two inner tags.

FREQUENCY CALIBRATION

To set up the Signal Generator it is only necessary to align the frequency scale on one of the frequency ranges as the others will then be correct, if the capacitors selected by switch S1 are accurate. This is best done on the middle position of the Range switch, i.e. the 100Hz to 1kHz range.

Switch to this position, set the frequency knob to indicate 20 on its scale and adjust VR1 until the output, as measured on a suitable frequency meter, reads 200Hz. Turn the Frequency knob to indicate 90 on the scale and adjust VR3 to give an output of 900Hz. Repeat this procedure a few times until no change is observed when turning from one position to the other.

This completes the calibration. The other ranges will be correct within the tolerance of their capacitors. ☐

EVERYDAY ELECTRONICS
INCORPORATING ELECTRONICS MONTHLY
The No. 1 Magazine for Electronic & Computer Projects

NEWSAGENT ORDER FORM

Please reserve/deliver a copy of
Everyday Electronics
for me each month

Signed...

Name and Address...
(BLOCK CAPITALS PLEASE)

....

....

Everyday Electronics is published on the first Friday of each month and distributed by Seymour.

Make sure of your copy of EE each month – cut out this form, fill it in and hand it to your newsagent.

EVERYDAY ELECTRONICS
INCORPORATING ELECTRONICS MONTHLY
The No. 1 Magazine for Electronic & Computer Projects

SUBSCRIPTION ORDER FORM

Annual subscription rates (1991): UK £18.50.
Overseas £23 (surface mail) £40.50 (airmail)

To: Everyday Electronics, 6 Church Street
Wimborne, Dorset BH21 1JH

Name...

Address...

....

....

I enclose payment of £ .... (cheque/PO in £ sterling only payable to Everyday Electronics)
Access or Visa No.

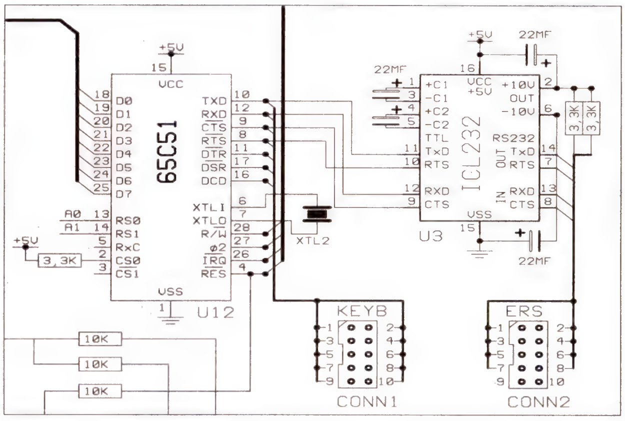
Signature.. Card Ex. Date ....
Please supply name and address of card-holder if different from the subscription address shown above. **Subscriptions can only start with the next available issue.** For back numbers see the Editorial page.

IMPORTS **EASY** PC FILES
UPGRADE DISCOUNT AVAILABLE

Finally...an exceptional PCB and Schematic CAD system for every electronics engineer!

BoardMaker 1 is a powerful software tool which provides a convenient and professional method of drawing your schematics and designing your printed circuit boards, in one remarkably easy to use package. Engineers worldwide have discovered that it provides an unparalleled price performance advantage over other PC- based systems.

BoardMaker 1 is exceptionally easy to use - its sensible user interface allows you to use the cursor keys, mouse or direct keyboard commands to start designing a PCB or schematic within about half an hour of opening the box.



Produce clear, professional schematics for inclusion in your technical documentation.

HIGHLIGHTS

Hardware:

- IBM PC, XT, AT or 100% compatible.
- MSDOS 3.x.
- 640K bytes system memory.
- HGA, CGA, MCGA, EGA or VGA display.
- Microsoft or compatible mouse recommended.

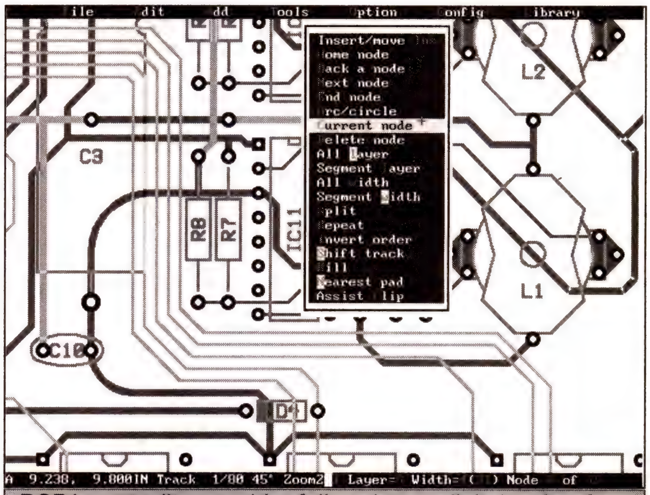
Capabilities :

- Integrated PCB and schematic editor.
- 8 tracking layers, 2 silk screen layers.
- Maximum board or schematic size - 17 x 17 inches.
- 2000 components per layout. Symbols can be moved, rotated, repeated and mirrored.
- User definable symbol and macro library facilities including a symbol library editor.
- Graphical library browse facility.
- Design rule checking (DRC)- checks the clearances between items on the board.
- Real-time DRC display - when placing tracks you can see a continuous graphical display of the design rules set.
- Placement grid - Separate visible and snap grid - 7 placement grids in the range 2 thou to 0.1 inch.
- Auto via - vias are automatically placed when you switch layers - layer pairs can be assigned by the user.
- Blocks - groups of tracks, pads, symbols and text can be block manipulated using repeat, move, rotate and mirroring commands. Connectivity can be maintained if required.
- SMD - full surface mount components and facilities are catered for, including the use of the same SMD library symbols on both sides of the board.
- Circles - Arcs and circles up to the maximum board size can be drawn. These can be used to generate rounded track corners.
- Ground plane support - areas of copper can be filled to provide a ground plane or large copper area. This will automatically flow around any existing tracks and pads respecting design rules.

Output drivers :

- Dot matrix printer
- Compensated HP laser printer
- PostScript output.
- Penplotter driver (HPGL or DMPL).
- Photoplot (Gerber) output.
- NC (ASCII Excellon) drill output.

All trade marks acknowledged



PCB layout editor provides full analogue, digital and surface mount support - ground and power planes (hatched or solid)- 45 degree, arced and any angle tracks.

£95

Despite its quality and performance, BoardMaker 1 only costs £95.00. Combine this with the 100% buy back discount if you upgrade to BoardMaker 2 or BoardRouter and your investment in Tsien products is assured. Price excludes carriage and VAT.

Don't take our word for it. Call us today for a FREE demonstration disk and judge for yourself.

tsien

Tsien (UK) Limited
Cambridge Research Laboratories
181A Huntingdon Road
Cambridge CB3 0DJ
Tel 0223 277777
Fax 0223 277747

ACTUALLY DOING IT!

by Robert Penfold

FOR anyone just starting out on the hobby of electronics construction I could not really recommend making your own printed circuit boards. There will be plenty of skills to master without adding a few more to the list by making your own circuit boards. Initially it is much better to use stripboard, or better still, a ready-made custom printed circuit board. This keeps the task as simple as possible, and optimises your chances of success.

You will probably want to try your hand at printed circuit making before too long though, and I suppose that it is something which every electronics hobbyist should try at some stage or other. To be honest, it is a pastime that is not everyone's "cup of tea". It involves the use of some messy chemicals, one of which is practically guaranteed to permanently stain any clothing, carpets, etc. that it comes into contact with.

I suppose that messing around with chemicals is one of those things you either love or hate, with few people being indifferent about it. Provided you are not put off by this aspect of making printed circuit boards, it is an interesting and rewarding part of the hobby.

SIMPLE METHODS

Making printed circuit boards can be as simple or complicated as you care to make it. At one extreme you can use simple equipment such as pens and hand-drills, while at the other you can use photographic methods, special "bubble" etching tanks, and all sorts of paraphernalia. In this Actually Doing It article we will take a look at the more simple methods, which are the best starting point. These will give you a "taste" of printed circuit board construction without involving you in great expenditure.

If you decide that this aspect of the hobby is one that does not really interest you, then you will not have wasted much money. If you do decide to pursue this aspect of things, then you may find that the simple techniques are all that you will need. However, if you are going to get involved in a lot of printed circuit construction, it would probably be advisable to progress to more advanced methods. These will be discussed in the next Actually Doing It article.

The basic printed circuit board material consists of a piece of board made from an insulating material, and covered with a thin layer of copper on one or both sides. Some designs for the home constructor are based on double-sided boards, but the vast majority use single-sided types. Making double-sided boards is not an easy task, and is certainly not a good starting point. Initially you should content yourself with fairly simple single-sided designs.

LAMINATE

Two types of copper laminate board are readily available, and these are the s.r.b.p. and fibreglass varieties. These are simply the materials from which the boards are made. Fibreglass consists of fibres of glass plus polyester resin (a type of plastic), as used in boat building etc. This is the tougher type of board, and is the one preferred by many users. Be warned though, that the fibres of glass tend to rapidly blunt saws and drills. Special super-hard drills are available for drilling this material, but they are very expensive and break easily.

For most purposes s.r.b.p. (sheet resin bonded paper) is adequate, and this is the type I mainly use these days. This is much cheaper than fibreglass board, but is still quite tough. It is probably only worthwhile using the fibreglass type when a very large board is being made, or if it will have to accommodate a heavy component such as a mains transformer.

BASIC PROCESSES

In order to turn the raw board into a working printed circuit board there are two basic processes that must be undertaken. First the unwanted areas of copper must be removed, so as to leave a pattern of copper tracks that will connect all the components together in the appropriate manner. This is achieved using a simple etching process. Then holes for the component leads must be drilled. The components are mounted on the non-copper (top) side of the board, and their leadout wires are soldered to the copper tracks on the underside of the board.

This is very much like stripboard, but there are some important differences. With stripboard the tracks are of uniform width, even at the points where there are holes for leadout wires. With custom printed circuits the tracks are often of several widths, are generally quite narrow, and widen out to form pads at the points where there are holes for leadout wires. Obviously there are only holes where they are needed, and the tracks can go in any direction.

On many boards the track shapes are quite intricate. This enables more compact layouts to be achieved, and usually enables fewer link wires to be used. In fact there may be no need for link wires at all, which is not usually possible when using stripboard.

TRACING

Once a board of the correct size has been cut out, the copper track pattern must be marked on the copper side of the board using etch resist. The board is then immersed in etchant, which removes the exposed areas of copper, but leaves the areas covered by the resist.

Before the track pattern is drawn onto the board it is essential that the copper side of the board is cleaned to produce a bright and shiny finish. This ensures that the board will etch efficiently. A dirty board may etch very slowly, giving poor results. It is even possible that some areas of the board will fail to etch at all.

Cleaning the board is very simple, and there are special abrasive blocks for this purpose. Alternatively, wire-wool gives good results, as do "Brillo-Pads" and scouring powders. The difficult part is keeping the cleaned board in good condition. Touching the copper surface will leave finger marks that might prove reluctant to etch. Try to only hold the board by the edges once it has been cleaned.

Next the track pattern must be traced from the diagram in the magazine or book onto the copper side of the board. There are various ways of doing this, and you may have your own "pet" method of doing this type of thing. The method I have always found most satisfactory is to first make a photocopy of the design. There is a potential problem here in that many photocopiers produce a copy that is slightly smaller than the original. In most cases the slight shrinkage will not be enough to cause any problems, and the more modern photocopiers seem to be largely free from this trait anyway.

The copy is fixed on the copper side of the board using double-sided tape. If you are prepared to cut up the book or magazine, you can use the original diagram (which should guarantee accurate results). You can now mark the positions of the holes in the board, using a sharp instrument such as a bradawl to make small indentations in the board at the appropriate points. Do this as accurately as possible. Later these indentations will act as guides when drilling the holes in the board.

With a complex board it might be advisable to gently scratch further navigation points onto the boards, such as the corners of intricate tracks. With the drawing and tape removed you can then use your selected method to add the etch resist.

ETCH RESIST

The resist can be a water resistant paint or ink applied by brush. However, the complexity of most modern boards is such that this method is not very practical these days. Rather than a brush, it is more normal for a fibre-tipped pen having a spirit based ink to be used. These enable quite fine designs to be produced with good neatness.

Many of the larger component retailers sell pens for this purpose, but just about any pen having a fine tip and a spirit based ink seems to be suitable. You may well already have something suitable. If in doubt, you can always do a test run on a small scrap of copper clad board to see if the ink will resist the etchant properly.

A popular alternative to a pen is to use etch resist transfers. These are rub-on transfers, and there are various types available (pads, tracks, d.i.l. clusters for integrated circuits, edge connectors, etc.). With these it is possible to produce really professional looking results, but they are much more time consuming to use. They are also more expensive. Most people find they provide a more satisfactory method of laying down the resist pattern, and I would have no hesitation in recommending this method.

You need to be careful when ordering etch resist transfers, as they are sometimes mixed in with drafting materials in the component catalogues. These drafting materials are for drawing up printed circuit boards on translucent film so that they can be produced using photographic methods. These are mostly of no use in the current context. Therefore, be careful that the items you order are described as "etch resistant", or something similar.

When drawing the copper pattern onto the board it is best to start with the pads. Then add the tracks, starting with the simple ones and finishing with the most complex tracks. If the copper pattern is produced using a pen, make sure that a generous thickness of resist is applied at every point on the pattern.

If you are using rub-on transfers the tracks must be cut to length before they can be rubbed into place. Simply position the transfer sheet on the board with a length of "track" in place, but have the sheet up-side-down. You can then carefully cut the "track" to length using a scalpel or sharp modelling knife, making sure it is fractionally over-length. Turn the sheet over, and rub the track into place on the board, making sure that both ends slightly overlap their respective pads. Also be sure to have a reasonable overlap at any corners of convoluted track runs.

ETCHING

If you use an etch resist pen, make sure that the resist has dried properly before etching the board. Most etch resist pens have a very quick drying ink, so it should not be necessary to wait more than a few minutes for the resist to dry thoroughly.

The standard etchant for do-it-yourself printed circuit making is ferric chloride. Of the various chemicals that are suitable for the job this is about the least dangerous, but it still needs to be treated with due respect. In minute quantities it is apparently used for water purification, but the strong solutions used for etching are decidedly poisonous. It should not be stored in lemonade bottles etc. It attacks many metals, and it must therefore be stored in containers which are entirely metal-free. The bottles that are sold for use with photographic chemicals are probably the best choice.

Ferric chloride can be washed from formica worktops etc. without any difficulty, but it will probably put a permanent yellow-brown stain into any clothing, carpets, towels, etc. that it touches. It will not etch your skin, but it is an irritant. If any of this chemical is spilled, always clean it up immediately. If any should get it on your skin, wash it off at once with plenty of soap and water. Always try to avoid getting ferric chloride anywhere that it should not be.

Ferric chloride is available as a solution ready for use, or in some cases requiring one-to-one dilution with water before use. This is the most convenient form in which to buy it, but it is not the cheapest. Usually solid forms of the chemical are significantly cheaper, and these days it only seems to be pellets that are available. These will dissolve quite easily in warm water with occasional stirring or agitation.

Opinion seems to vary as to the optimum dilution for etching purposes. Some advocate a saturated solution, which means using equal weights of water and ferric chloride (i.e. add a 250gm pack of ferric chloride to 250ml of water). I prefer to use a half strength solution, and to make up one litre or so at a time. I therefore add two 250gm packs of the chemical to 1 litre of water.

Photographic dishes and plastic tongues are well suited to making printed circuit boards. Place the board copper side uppermost in a dish and add sufficient ferric chloride to thoroughly cover the board. Etching is quickest if the board and solution are constantly agitated.

The need for agitation can be avoided if the board is suspended up-side-down in the solution, or if it is positioned vertically in the solution. This generally requires some form of etching tank, or a very large jar. If you can improvise something suitable it will make the etching process much easier, and will probably be well worth the effort involved.

Inspect the board frequently to see how etching is progressing. The time taken depends on factors such as the strength of the solution, how much it has been used, the size of the board, and the temperature of the solution. It can take as little as ten minutes, but with a large board and well used etchant it can take over an hour. It is important not to leave the board in the etchant for any longer than is really necessary as this could cause severe undercutting of the tracks and pads.

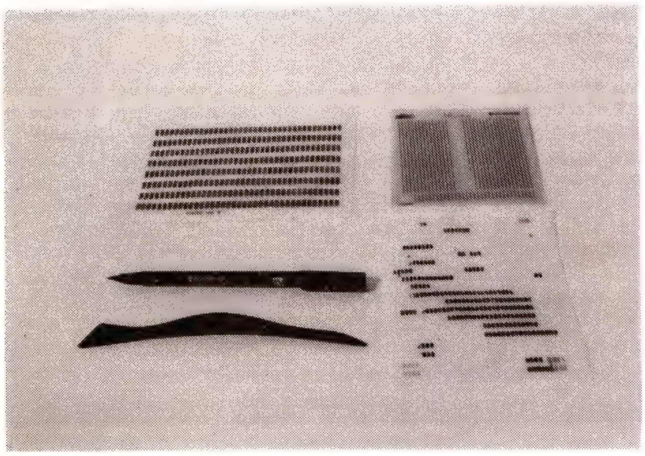
Once the board has completely etched, remove it from the etchant and rinse it thoroughly. The resist must then be removed, and this can be done using the same methods that were originally used to polish the board. The board is then ready for drilling.

Most components require 1 millimetre diameter holes, but for most semiconductors 0.8 millimetres is a better size. A few components, such as preset resistors, require larger holes of about 1.6 millimetres in diameter. The holes can be drilled using a small hand-drill, but this is a slow way of doing things. Also, the drills will tend to snap quite frequently, and the harder miniature drill bits are strictly for use in power drills.

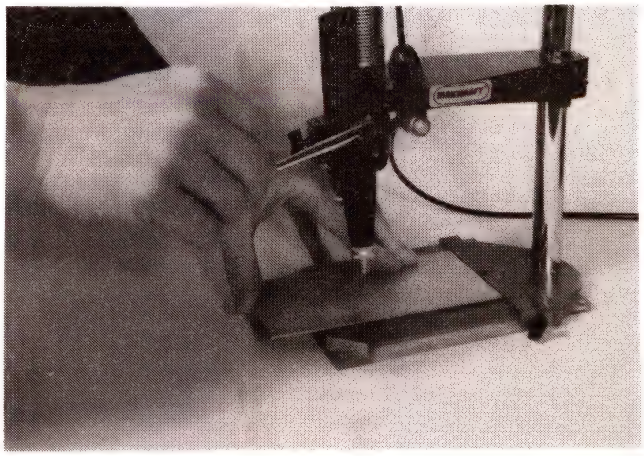
A full-size power drill mounted in a stand is usable, but it is probably worth investing in one of the inexpensive miniature electric drills that are available from some component retailers. With one of these plus a matching stand it is possible to drill the holes at a fair rate, and with good accuracy. Provided you proceed with reasonable care, snapped drill bits should then be a rarity.

Cleaning the board with an abrasive block.

Etch resist transfers and pen, with rubbing down tool.



Drilling the board with a miniature drill and drill stand.



FOR YOUR ENTERTAINMENT

by Barry Fox

Old Idea – New Batteries

Nice to see the *Mail on Sunday* pick up on one of Everyday Electronics' constructional projects (September 1991) with a story about the "schoolboy project which is causing fury in Britain's £250 million pound battery industry".

Alan Tong had described how to build a Dry Cell Re-charger from components costing only around £8.50. He poo-poohed the warnings printed on dry cell labels which threaten danger of leakage or explosion if people try and recharge dry cells. But Tong emphasised that there is no point in even trying to recharge dry cells in NiCad chargers.

NiCad chargers simply push d.c. back through the cell in reverse. This neatly recomposes the chemistry of a NiCad cell because it is designed for recomposition. But if straight d.c. is pushed through a dry cell, recomposition produces a disorderly chemical mass which takes up too much space. This pops the safety vent to make the cell leak. And the cell holds virtually no charge anyway.

Predictably the battery manufacturers mouthed all the usual warnings. It suits them very nicely if people go on throwing cells away instead of recharging them. And my experience of salesmen in the battery business is that they know very little about the curious mix of electrochemistry, cookery and black magic on which their livelyhoods depend.

Also, all this rang bells in the back of my brain and I dug out a file from exactly ten years ago. Sorry to say it, but recharging dry cells is by no means a new idea. *(We understand that it was done in the second world war – Ed.).*

At the May 1981 electronics industry trade shows in London, British company Fidelity Radio of North London launched the Battery Saver. This was a portable mains/battery radio with a special feature; it incorporated a dry battery charger.

While the radio was plugged into the mains, but not in use, the charger fed a mixture of a.c. and d.c. power back into the batteries. The a.c. was superimposed on the d.c. to prevent the zinc from reforming as dendrites which take up too much space and flake off the electrode. The mixed a.c./d.c. charge was fed as a variable trickle, over a long period of time. The charge rate in the Fidelity radio started at around 24 milliamps and fell away to zero as the 9 volt battery pack returned to a nominal voltage of 8.7 volts.

At the time Fidelity described this as "a British technology breakthrough which could revolutionize the design of many battery powered home electronic products". The Battery Saver sank without trace, Fidelity ran into financial problems and the name was bought by Amstrad.

Environmental thinking makes the time right for a radio which recycles cells. Alan Sugar of Amstrad is not the kind of man to worry about offending the battery industry.

New Idea – Old Batteries!

There is something very interesting buried in the small print of a new brochure from Aiwa, subsidiary of Sony, and purveyor of high tech and stylish portable stereos of the Walkman type.

"Personal stereo users are discovering the economy of rechargeable batteries", says Aiwa, "yet often find long recharge time inconvenient".

Too true.

And nicad rechargeable cells never seem to work as well as the adverts or spec sheet claims. There is good reason for this.

The text books tell that nicad cells should be completely discharged before recharging, not continually topped up. Some chargers used to discharge the cells before starting to charge them. But this increases both cost and charging time. The feature now seems to have been dropped, for reasons of price and overall charging time.

Some portable telephones, which use nicad cells, now have circuitry built in which control complete discharge. Users are advised to trigger the circuit once a month. But there is no way this kind of circuitry can be built into budget domestic equipment, especially if it is designed to take either expendable or rechargeable cells.

Not surprisingly, people top up the nicads for a portable stereo or computer to be sure of having a full charge before leaving home. This topping up creates a memory effect, whereby the cell is only able to hold a part charge.

Aiwa is now going back to the good old lead acid battery, as used in cars, albeit with the electrolyte in a sticky gel, rather than acid water. New Aiwa portable stereos have lead acid gel batteries. These can take a far heavier charge current than nicads, making it possible to recharge a portable stereo in just ten minutes. Before that Sony had used lead acid batteries for portable CD players.

There is another advantage. Lead acid cells like to be continually topped up, which is of course what happens in a car. So they are ideal for real world use of portable stereos and computers.

But be warned. If you run a lead acid cell flat, do not leave it flat. Irreversible chemical changes will then take place which prevent it ever again holding a charge.

Will Rabbit run for Hutch?

Earlier this year I wrote about the insanity of the CT2 (second generation digital cordless phone) market, and referred to the fourth incompatible service, called Rabbit from BYPS. This is the consortium of Philips, Shell and Barclays. Or rather it was. Hong Kong communications company Hutchison, has bought BYPS.

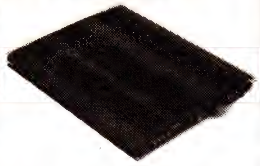
Hutchison is very successful in Hong Kong, as a cellular radio phone operator. If anyone can make Rabbit run, it will be Hutchison. Witness what happened over the crazy publicity stunt adopted by BYPS, which broke the cardinal rule of advertising – don't encourage the public to buy something until it is actually on sale.

BYPS has been paying for "Try Rabbit" signs round the edge of rugby and cricket pitches. As Rabit CT2 phones were not on sale, anyone who watched sport on TV and saw a "Try Rabbit" sign could only wonder what on earth it meant. Apparently anyone going to a rugby match learned all about it from a full page advert in the printed programme. The exhortation to "try" is a word play on rugger "tries".

I asked Philips why they were letting BYPS squander a fortune on perimeter advertising which encouraged millions of people without the printed programme explanation to try something that wasn't available. Why not save the money on perimeter advertising and just rely on the printed programme page inside?

Before I got an answer the Chinese had bought the company. The daft adverts have now disappeared. I suspect some of the BYPS staff will disappear too.

2 x 220 watt MOSFET AMPLIFIER



A top-of-the-range performer that will satisfy the most demanding audio enthusiast. If you're looking for an amplifier to power your subwoofer, the **SPARKOMATIC** is all you'll need! Highly sophisticated MOS-FET technology dramatically extends frequency response, separate input sensitivity controls, built-in protection circuitry for overheat and short circuit with l.e.d. indication, output power: 2 x 220 watt maximum and 2 x 110 watt at 0.1% THD, Bridged 440 watt mono maximum and 220 watt mono at 0.5% THD.

£164.50 plus £3.50 P&P

100 watt x 4 CLASS A AMPLIFIER FOR CARS

Delivers 4 x 100 watt into 4 woofers or with the aid of its built in active cross over delivers 200 watt of Bass via sub-woofer output and 2 x 100 watt, full range into 2 speakers; thus giving you all the power you require to make even traffic jams a positive pleasure. SPECIFICATION 4 x 100W (4Ω), 2 X 200w Bridged, THD .08%, S/N RATIO: 7 90db, RESPONSE 10Hz-50KHz, LOW PASS FILTER SWITCHED 75Hz 150Hz, INPUT 4 x PHONO 100-3 Volts, INPUT x 4 HIGH LEVEL 20KΩ, SIZE 240mm x 50mm x 400mm.

£118.50 postage £4.50

75 watt x 2 CLASS A AMPLIFIER FOR CARS

Small but powerful, high efficiency amplifier, suitable for a number of hidden mounting locations. Easy connection through phono and high level input capability. SPECIFICATION 2 x 75 watts 4Ω, 1 x 150 watt Bridged, THD 0.190, S/N RATIO: 7 85 dB, RESPONSE 20Hz-30KHz. INPUTS; 2 X PHONO 100mV-3 VOLT 2 X HIGH LEVEL 2 X 20kΩ. SIZE 240mm X 50mm X 140mm.

£48.50 postage £3.50

11 BAND COMPONENT GRAPHIC EQUALIZER FOR CARS

This neat unit connects between the line output of your car stereo and your power amplifiers so you are able to adjust the sound as in a studio compensating for soft furnishing and sound reflections from glass, also it has a sub-woofer output to drive a separate amplifier for that extra deep bass sound. FEATURES: 2 channel inputs 4 channel outputs via phono sockets, CD input via 3.5mm jack 11 band graphic. SPECIFICATION RANGE 20Hz-60KHz THD 0.05%, S/N RATIO 85dB. EQ FREQUENCIES 60HZ, 120Hz, 250Hz, 380 Hz, 500 Hz, 750 Hz, 1 KHz, 2KHz, 4KHz, 8KHz, 16KHz (Boost cut of ±12 dB) SIZE 178mm x 25mm x 140mm.

£32.70 postage £1.80.

EMINENCE 4Ω PROFESSIONAL USA MADE IN CAR CHASSIS SPEAKERS

All units are fitted with big magnets "Nomex" Voice coils NOT ALUMINIUM, "Nomex" is very light and can stand extremely high temperatures, this mixture makes for high efficiency and long lasting quality of sound.

V6 6 ½" 200W Max	Range 50Hz-3KHz	**£34.40**
V8 8" 300W Max	Range 45Hz-3KHz	**£39.35**
V10 10" 400W Max	Range 33Hz-4KHz	**£44.45**
V12 12" 400W Max	Range 35Hz-3KHz	**£45.95**
BOSS 15" 800W Max	Range 35Hz-4KHz	**£79.90**
KING 18" 1200W Max	Range 20Hz-1KHz	P.O.A.

Postage **£3.85** per speaker.

AUDAX JBL 40-100 watt CAR TWEETERS

These state of the art advanced technology, high performance 10 mm dome tweeters are Ferrofluid coded and are active horn-loaded for high dispersion of sound with very low distortions. Ideal for tuning up your dull sounding in-car system. SPECIFICATION IMP4Ω 40 watts at 5KHz, 100 watt at 10KHz, MAGNET, SIZE 5mm x 30mm, VOICE COIL SIZE 10.5mm EIFFICIENCY 92.8 dB. SIZE 51mm x 51mm x 16.5mm. RECOMMENDED. 5k. 1st ORDER CROSSOVER, VALUE 1.5uf-2.2uf supplied. **£7.50**pair plus **90p post.**

MAIL ORDER £1 BARGAIN PACKS BUY 20 GET 1 FREE

Please state pack(s) required

No.	Qty. per pack	
BP015B	1	30W dome tweeter. Size 90x66mil *JAPAN made*
BP017	3	33000µF 16V d.c. electrolytic high quality computer grade *UK made*
BP019	20	20 ceramic trimmers
BP020	4	Tuning capacitors, 2 gang dielectric a.m. type
BP021	10	3 position, 8 tag slide switch 3 amp rated 125V a.c. *made in USA*
BP022	5	Push-button switches, push on push off, 2 pole changeover. PC mount *JAPAN made*
BP023	6	2 pole 2 way rotary switch
BP024	2	2 Right angle, PCB mounting rotary switch, 4 pole, 3 way rotary switch *UK made by LORLIN*
BP025	4	3 pole, 3 way miniature rotary switch with one extra position off (open frame YAXLEY type)
BP026	4	4 pole, 2 way rotary switch *UK made by LORLIN*
BP027	30	Mixed control knobs
BP029	6	Stereo rotary potentiometers
BP030	2	10k wire wound double precision potentiometers *UK made*
BP032	4	UHF varicap tuner heads, unboxed and untested *UK made by PHILIPS*
BP033	2	FM stereo decoder modules with diagram *UK made by PHILIPS*
BP033A	4	6"x⅜" High grade Ferrite rod. *UK made*
BP034	3	AM IF modules with diagram *PHILIPS UK MADE*
BP034A	2	AM-FM tuner head modules. *UK made by Mullard*
BP034B	1	Hi-Fi stereo pre-amp module inputs for CD, tuner, tape, magnetic cartridge with diagram. *UK made by MULLARD*
BP035	6	All metal co-axial aerial plugs
BP036	6	Fuse holders, panel mounting 20mm type
BP038	20	5 pin din, 180° chassis socket
BP039	6	Double phono sockets, Paxolin mounted
BP041	3	2.8m lenghts of 3 core 5 amp mains flex
BP042	2	Large VU meters *JAPAN made*
BP043	30	4V miniature bulbs, wire ended, new untested
BP044	2	Sonotone stereo crystal cartridge with 78 and LP styli *JAPAN made*
BP045A	2	Mono Cassette Record and play heads
BP046A	2	606 Mains transformers, PCB mounting. Size 42x33x35
BP047A	1	25V DC 150mA mains adaptor in black plastic case with flying input and output leads new units made for famous sound mixer manufacturer. Size 80x55x47
BP049	10	OC44 transistors. Remove paint from top and it becomes a photo-electric cell (ORP 12). *UK made by MULLARD*
BP050	30	Low signal transistors n.p.n., p.n.p. types
BP051	6	14 watt output transistors. 3 complimentary pairs in TO66 case. *(Ideal replacement for AD161 and 162s)*
BP052A	1	Tape deck pre-amp IC with record/replay switching No LM1818 with diagram
BP053	5	5 watt audio ICs. No TBA800 *(ATEZ)*
BP054	10	Motor speed control ICs, as used with most cassette and record player motors
BP055	1	Digital DVM meter I.C. *made by PLESSEY* as used by *THANDAR* with diagram
BP056	4	7 segment 0.3 LED display (red)
BP057	8	Bridge rectifiers, 1 amp, 24V
BP058	200	Assorted carbon resistors
BP059	1	Power supply PCB with 30V 4V/A transformer. MC7818CT IC & bridge rectifier: Size 4" x 2¾"
BP061	5	6.35mm Mono jack plugs
BP063	5	6.35mm stereo switched jack sockets
BP064	12	Coax chassis mount sockets
BP065	1	3mtr Euro-mains lead with chassis socket

Postage £3 per order

ROADSTAR OF SWITZERLAND. QUALITY 13cm 40 watt CAR SPEAKERS. Fitted with dual polypropylene cone and foam rubber surround. Large 70mm magnet for good bass and treble response. Supplied complete with grills, fixing screws and cable.

OFFER PRICE £11.70 pair

They weigh nearly 1.5kg. Postage £3.15 each

2 pairs for £22 POST PAID UK ONLY

UNDER ½ PRICE OFFER

AUSTIN ROVER MINI MAYFAIR. 15 watt POD SPEAKERS. Moulded in a black housing for vertical or horizontal use. Fitted with a good mains 10cm speaker.

£4.95 pair plus £3 pp or

2 pairs for £10.50 post paid UK only

BSR STEREO RECORD PLAYER DECK

Manual auto operation, 3 speed (78, 45, 33⅓), 240V opertion. unused but store soiled.

£10.50 ea P&P £3.75 2 for £18.00 P&P £3.75

RADIO AND TV COMPONENTS ACTON LTD
323 EDGWARE ROAD LONDON W2 1BN

MAIL ORDER TERMS. POSTAL ORDERS and or CHEQUES with orders
Nett monthly accounts to Schools, Colleges and P.L.C. only
ACCESS VISA Phone orders between 9.30-12pm please. Overseas readers write for quote on delivery

Phone 071 723 8432 or 081 992 8430

323 Edgware Road, London W2 1BN. Closed Sun

AMPHONIC 125+125 POWER AMPLIFIER

125 watt per channel stereo power amplifier with independent volume controls, professional 19" rack mount and silent running cooling fan for extra reliability.

Output power	125W RMS max. per channel
Output impedance	4 to 16 ohms (max power into 4 ohms)
Sensitivity	450V at 22K ohms
Protection	Electronic short-circuit and fuses
Power	220-240V a.c. 50Hz
Chassis dim.	435 x 125 x 280mm

£170 + £7.00 pp

30+30 WATT AMPLIFIER KIT

An easy to build amplifier with a good specification. All the components are mounted on the single PCB which is already punched and backprinted.

- 30W x 2 (DIN 4 ohm)
- CD/Aux, tape I, tape II, tuner and phono inputs.
- Separate treble and bass.
- Headphone jack.

Size (H.W.D.) 74 x 400 x 195mm.

Kit enclosed: case. PCB, all components, scale and knobs **£40.00** + £3.50 pp.

(Featured project in *Everyday Electronics*, April 1989 issue). Reprint Free with kit.

MULTIBAND RADIO

VHF 54-176MHz + AM CB BANDS 1-80
Listen to: AIR TRAFFIC CONTROL, AIRCRAFT, RADAR, PUBLIC UTILITIES, RADIO AMATEURS AND MANY MANY MORE
SQUELCH CONTROL
AERIAL

£17.95
POSTAGE £2.85

ROSS PUSH BUTTON RADIO

Mains and battery operated.
High quality VHF/FM, Medium and Long Wave reception.
6 push button selected preset stations.
Fully retractable telescopic aerial
Headphone/earphone jack socket.
Size 230H x 150W x 65D
Ref. RE-5500
Brand new.
Listed price over £30.00

OFFER £15.00
+ £2.80 pp

VIDEO SENDER

With this handy unit you can transmit the output of your home video, video camera or satellite equipment over-the-air to a receiving television within a range of 100ft. Simply connect the video and audio output of your equipment into this unit and a 10-13.8V dc power supply extra **£3.75** size 122 x 70 x 21mm

£11.50 + £2 pp

VHF RADIO TRANSMITTERS

100mW mini bug. Built on a neat little fibre glass pcb with condenser mic. Fully tunable over the FM band. 9V DC **£5.75** + £0.90 pp

2 Watt transmitter kit, supplied with fibre glass pcb, all components, diagrams, ready for you to build. 12-24V DC. **£7.50** + £0.70 pp

25 Watt Transmitter kit. Fully tuneable over the FM band. Kit comprises double sided pcb diagrams and all components, including heat sink. Supply voltage 12-18V DC. **£67** + £1 pp

Transmitters listed on this page are not licensable in the UK.

SPECIAL OFFER

DTMF TONE DIALLER

Suitable for remote control of telephone answering machines, videos, appliances etc. requiring DTMF signals over telephone lines.

£8.95

Please add 75p p&p when ordering

Please add 2.2% to all our prices due to the increase of the VAT rate to 17.5%

SURVEILLANCE

PROFESSIONAL QUALITY KITS

No. 1 for Kits

Whether your requirement for surveillance equipment is amateur, professional or you are just fascinated by this unique area of electronics SUMA DESIGNS has a kit to fit the bill. We have been designing electronic surveillance equipment for over 12 years and you can be sure that all of our kits are very well tried, tested and proven and come complete with full instructions, circuit diagrams, assembly details and all high quality components including fibreglass PCB. Unless otherwise stated all transmitters are tuneable and can be received on an ordinary VHF FM radio.

UTX Ultra-miniature Room Transmitter
Smallest room transmitter kit in the world! Incredible 10mm x 20mm including mic. 3-12V operation. 500m range £16.45

MTX Micro-miniature Room Transmitter
Best-selling micro-miniature Room Transmitter
Just 17mm x 17mm including mic. 3-12V operation. 1000m range £13.45

STX High-performance Room Transmitter
Hi performance transmitter with a buffered output stage for greater stability and range. Measures 22mm x 22mm including mic. 6-12V operation, 1500m range £15.45

VT500 High-power Room Transmitter
Powerful 250mW output providing excellent range and performance. Size 20mm x 40mm. 9-12V operation. 3000m range £16.45

VXT Voice Activated Transmitter
Triggers only when sounds are detected. Very low standby current. Variable sensitivity and delay with LED indicator. Size 20mm x 67mm. 9V operation. 1000m range... £19.45

HVX400 Mains Powered Room Transmitter
Connects directly to 240V AC supply for long-term monitoring. Size 30mm x 35mm. 500m range £19.45

SCRX Subcarrier Scrambled Room Transmitter
Scrambled output from this transmitter cannot be monitored without the SCDM decoder connected to the receiver. Size 20mm x 67mm. 9V operation. 1000m range £22.95

SCLX Subcarrier Telephone Transmitter
Connects to telephone line anywhere, requires no batteries. Output scrambled so requires SCDM connected to receiver. Size 32mm x 37mm. 1000m range £23.95

SCDM Subcarrier Decoder Unit for SCRX
Connects to receiver earphone socket and provides decoded audio output to headphones. Size 32mm x 70mm. 9-12V operation £22.95

ATR2 Micro Size Telephone Recording Interface
Connects between telephone line (anywhere) and cassette recorder. Switches tape automatically as phone is used. All conversations recorded. Size 16mm x 32mm. Powered from line £13.45

★★★ Specials ★★★

DLTX/DLRX Radio Control Switch
Remote control anything around your home or garden, outside lights, alarms, paging system etc. System consists of a small VHF transmitter with digital encoder and receiver unit with decoder and relay output, momentary or alternate, 8-way dil switches on both boards set your own unique security code. TX size 45mm x 45mm. RX size 35mm x 90mm. Both 9V operation. Range up to 200m.
Complete System (2 kits) £50.95
Individual Transmitter DLTX £19.95
Individual Receiver DLRX £37.95

MBX-1 Hi-Fi Micro Broadcaster
Not technically a surveillance device but a great idea! Connects to the headphone output of your Hi-Fi, tape or CD and transmits Hi-Fi quality to a nearby radio. Listen to your favourite music anywhere around the house, garden, in the bath or in the garage and you don't have to put up with the DJ's choice and boring waffle. Size 27mm x 60mm. 9V operation. 250m range £20.95

UTLX Ultra-miniature Telephone Transmitter
Smallest telephone transmitter kit available. Incredible size of 1mm x 20mm! Connects to line (anywhere) and switches on and off with phone use. All conversation transmitted. Powered from line. 500m range £15.95

TLX700 Micro-miniature Telephone Transmitter
Best-selling telephone transmitter. Being 20mm x 20mm it is easier to assemble than UTLX. Connects to line (anywhere) and switches on and off with phone use. All conversations transmitted. Powered from line. 1000m range £13.45

STLX High-performance Telephone Transmitter
High performance transmitter with buffered output stage providing excellent stability and performance. Connects to line (anywhere) and switches on and off with phone use. All conversations transmitted. Powered from line. Size 22mm x 22mm.
1500m range £16.45

TKX900 Signalling/Tracking Transmitter
Transmits a continous stream of audio pulses with variable tone and rate. Ideal for signalling or tracking purposes. High power output giving range up to 3000m. Size 25mm x 63mm. 9V operation £22.95

CD400 Pocket Bug Detector/Locator
LED and piezo bleeper pulse slowly, rate of pulse and pitch of tome increase as you approach signal. Gain control allows pinpointing of source. Size 45mm x 54mm. 9V operation £30.95

CD600 Professional Bug Detector/Locator
Multicolour readout of signal strength with variable rate bleeper and variable sensitivity used to detect and locate hidden transmitters. Switch to AUDIO CONFORM mode to distinguish between localised bug transmission and normal legitimate signals such as pagers, cellular, taxis etc. Size 70mm x 100mm. 9V operation £50.95

QTX180 Crystal Controlled Room Transmitter
Narrow band FM transmitter for the ultimate in privacy. Operates on 180 MHz and requires the use of a scanner receiver or our QRX180 kit (see catlogue). Size 20mm x 67mm. 9V operation. 1000m range £40.95

QLX180 Crystal Cointrolled Telephone Transmitter
As per QTX180 but connects to telephone line to monitor both sides of conversations. 20mm x 67mm. 9V operation. 1000m range £40.95

QSX180 Line Powered Crystal Controlled Phone Transmitter
As per QLX180 but draws power requirements from line. No batteries required. Size 32mm x 37mm. Range 500m £35.95

QRX180 Crystal Controlled FM Receiver
For monitoring any of the 'Q' range transmitters. High sensitivity unit. All RF section supplied as a pre-built and aligned module ready to connect on board so no difficulty setting up. Outpt to headphones. 60mm x 75mm. 9V operation £60.95

A build-up service is available on all our kits if required.

UK customers please send cheques, POs or registered cash. Please add £1.50 per prder for P&P. Goods despatched ASAP allowing for cheque clearance. Overseas customers send sterling bank draft and add £5.00 per order for shipment. Credit card orders welcomed on 0827 714476.

OUR LATEST CATALOGUE CONTAINING MANY MORE NEW SURVEILLANCE KITS NOW AVAILABLE. SEND TWO FIRST CLASS STAMPS OR OVERSEAS SEND TWO IRCS.

SUMA DESIGNS

DEPT. EE
THE WORKSHOPS, 95 MAIN ROAD,
BAXTERLEY. NEAR ATHERSTONE,
WARWICKSHIRE CV9 2LE

☎ 0827 714476

DOWN TO EARTH

George Hylton

ADDING WITH AMPLIFIERS

CIRCUITS tend to get associated with particular applications. So much so that it's easy to overlook the possibility of using a "standard" circuit for some non-standard task.

MICROPHONE MIXER

A case in point is the circuit commonly used in audio systems for mixing inputs from several sources – microphones, for example. Reduced to its essentials (omitting irrelevant details such as coupling capacitors) this boils down to Fig. 1. Here V_1 and V_2 are inputs (from two microphones or whatever).

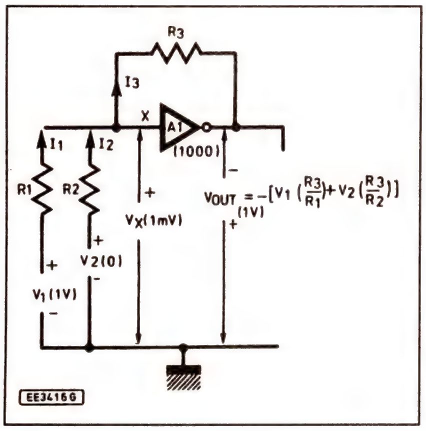


Fig. 1. Adding voltages with the aid of a feedback amplifier.

If R1 = R2 = R3, the output voltage (V_{out}) is the sum of the input voltages (V_1 and V_2), but with polarity inversion. Or, rather it's very nearly the sum. In practice, it is very slightly less, because exact summing is obtained only if the amplifier's gain is infinite.

NEGATIVE FEEDBACK

Infinite gain seems to imply infinite amplification, but the gain is reduced (to 1 in the present case) by negative feedback. With the signal polarities shown, signal current flows as the arrows indicate (I_1 and I_2). These input currents flow into point X. Now, if currents flow into something there is a build up of electric charge, producing a build-up of voltage. However, in the present case feedback from the (inverted) output causes a current I_3 to flow *out of* point X. This removes charge and so tends to counteract the build-up of voltage.

If the counterraction were totally effective there would be nothing left at point X, and since point X is the true input to A1 there would be no input voltage and so no output. What happens in practice is that the feed-back cancels as much of the input as it can. What's left is amplified to give a reduced output.

If the true (inner) amplification of A1 is 1000 and V_{out} is 1V then V_x (the voltage at X) must be 1mV. So the voltage at X may be very much less than V_1 or V_2. Suppose V_1 is 1V and V_2 is zero. Then the whole of V_{out} must be the result of V1. If $V_1 = 1V$ the signal voltage across R1 is the difference between V_1 (1V) and V_X (1mV). This is 999mV, which is so close to V_1 that the signal current driven by V_1 is almost identical to $V_1/R1$. By the same token, the feedback current driven by V_{out} through R3 is very nearly $V_{out}/R3$.

SCALING FACTOR

The upshot of all this is that the input current can be said (with very small error) to be $V_1/R1$ and feed-back current to be $V_{out}/R3$. These currents have opposite effect on the charge at point X and very nearly cancel it. It is therefore almost true to say that they are equal.

If we do say so, as a reasonable approximation, then the feed-back current equals the input current. The voltage at X being (nearly) zero, we can say (with very good approximation) that $V_{out}/R3 = V_1/R1$. If R3 = R1 then V_{out} must be the same as V_1 (except for a voltage inversion, positive to negative). If R3 is different from R1 then V_{out} is different from V_1. A bit of fiddling with numbers tells us that $V_{out}/V_1 = R3/R1$.

Since V_{out}/V_1 is the voltage gain to V_1, this means that if we want to amplify V_1 by 5 all we need do is make R3 = 5R1, and so on. Better still, since the voltage at X is always going to be small compared with the input voltage, the current driven by V_2 through R2 isn't going to be affected much by V_1.

If V_2 is not zero but 100mV then the 1mV at point X caused by V_1 can only change the voltage across R2 by 1mV, so it can't ever be far from 99mV. Once again, this is virtually the input voltage (V_2 in this case) so I_2 is always close to $V_2/R2$ and is scarcely affected by V_1. This is just what's wanted from a microphone mixer, where the signal from one microphone ought not to alter the signal from another.

The output (V_{out}) is the sum of the inputs, each changed by a "scaling factor" R3/R1, or R3/R2. Different gains for different inputs can be set by placing appropriate resistors between input and X.

FINITE GAIN

Earlier on I glibly assumed that the gain is 1000 and the signal voltage at X is 1mV. But what if the gain is other than 1000? All that happens is that V_x adapts itself to suit the new gain. For an internal amplifier gain of 100, V_x is $V_{out}/100$, which for our input of 1V means that V_x is 10mV. If the internal gain of A, is 10,000 then V_x is 0.1mV.

In all these cases V_x is sufficiently low to make our approximations reasonably accurate. If A1 rises they become even more accurate. Only if A1 falls to less than about 10 are they likely to lead to errors of more than a couple of decibels.

The mixer amplifier is not restricted to two inputs. Given a high gain A1, virtually any number of signals can be applied, each through an appropriate series resistance.

This kind of circuit is often called a virtual earth amplifier because the voltage at X is close to "earth" (zero) voltage. It's widely used in sound systems where its only major snag is noise. For good results when used as an input circuit A1 must be a low-noise amplifier. In practice designers may opt for a low-noise op.amp, with signals and feedback applied to the inverting input.

WAVEFORM ADDITION

This ability to add together input voltages has applications far beyond audio mixing. Recently I had need of a test oscillator capable of delivering sine waves and square waves. Its job was to provide test signals for an audio amplifier. Being far from home and friendly component suppliers I needed to make do with what was available. My stocks in fact amounted to a fair selection of passive components, some transistors and a few simple CMOS chips.

Getting square waves was easy. A simple free-running relaxation oscillator (Fig. 2) made from two inverters (A1, A2) gave a squarish output which could be tidied up by a third inverter (A3) to give reasonable square waves. But what about sine waves? If triangular waves could be obtained (Fig. 3a) their peaks might be crushed by making them overload an amplifier to give an approximation to sine waves (Fig. 3b).

It is quite possible to convert square waves to isoscles triangles by passing them through an integrator circuit. However, as the frequency rises the amplitude falls. What I wanted was waves of constant amplitude.

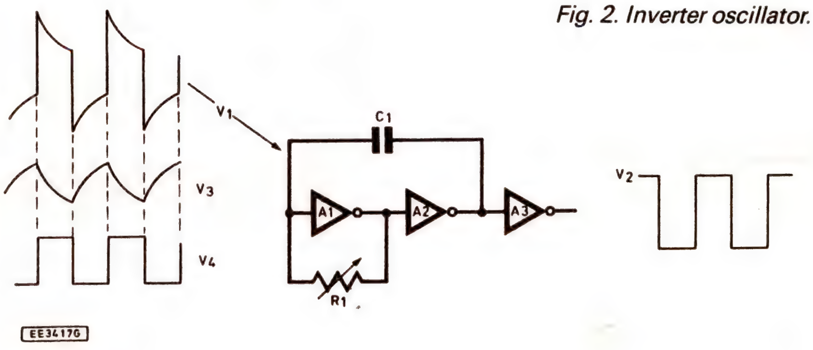


Fig. 2. Inverter oscillator.

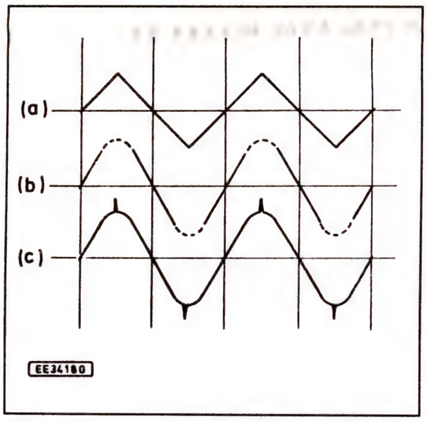


Fig. 3. Making a "sine wave" from a triangular wave.

SUBTRACTION

After fiddling around and getting nowhere it dawned on me that the answer had been staring at me all along from the face of my 'scope. The waveform (V_1) at the input to A1 can be read as the sum of a distorted triangular wave (V_3) and a square wave (V_4). To separate the triangular wave all that is needed is to subtract the square wave from V_1. Subtraction can be turned into addition by first inverting what you want to subtract.

I had plenty of inverters (six on a 4069, of which I'd only used three for the oscillator). In fact, A3 was already performing the necessary inversion. All I had to do was apply V_1 and V_2 to a virtual earth mixer, through suitable scaling resistances, to obtain V_3, then crush it.

SERENDIPITY

In fact, what I got after a bit more fiddling was waveform (3c). This is fairly like a sine wave except for pips at the peaks, caused by stray coupling of energy from the edges of the square waves. In theory the pips, being made up of high harmonics could be attenuated with a low-pass filter. After thinking how to arrange it I decided not to bother. Fortunately!

After passing through the amplifier under test, waveform (3c) emerged with pips which had become enlarged into hefty spikes. This indicated a fault; the response of the amplifier was peaking at high frequencies, causing distortion of transients. Which all goes to justify the lazy person's proverb: If a thing's worth doing it's worth doing badly!

SHOP TALK

with David Barrington

Audio Trends

Claiming a price breakthrough for a true sub-woofer loudspeaker line-up, **B.K. Electronics** have just marketed the Sub-Woofer Satellite System from Studio Power.

Targeted towards the customer who would normally choose a small pair of traditional loudspeakers, the Studio Power system consists of two "satellite" units and one bass "bin" and costs just £129 complete. All three units are finished in grey metallic.

The bass bin contains two bass units in a push/pull arrangement, which, it is claimed, gives a non-directional sub-bass sound and may be hidden behind the sofa, curtains or under the coffee table.

The two main enclosures or satellites each contain a 1in. tweeter and a 3in. mid-range speaker. The system's power handling is 60W r.m.s. (90W peak music power).

The Sub-Woofer Satellite System is priced at £129 (including VAT) plus £6 postage and is available from **B.K. Electronics, Dept EE, Unit 1/5, Comet Way, Southend-on-Sea, Essex SS2 6TR. (☎ *0702 527572*).**

Christmas Decoration – Simple Model Series

The melody i.c. UM66 is available in four versions with differing melodies, ranging from Christmas Carols to Elvis. The one used in the *Christmas Decoration*, this month's *Simple Model Series* project, is of course the Carols version and is designated Type 1 (UM66-1).

The circuit "board", Santa, sleigh and reindeer is built up on printed white card, which can be obtained from the EE Editorial Offices for the sum of £1.50 (including postage). The wiring up of the circuit card is accomplished by the use of the Vero Easiwire "no soldering" wire-wrapping system.

To help with assembly special arrangements have been made with **Bull Electrical (☎ *0273 203500*)** and **Greenweld Electronic Components (☎ *0703 236363*)** to supply a complete kit, including cards, for the sum of £4.95 plus £1 postage fee. – See *Special Offer* page 790.

Auto Nightlight

The only item required for the *Auto Nightlight* that requires special comment is the mains transformer. As this has to sit directly on the printed circuit board (p.c.b.) the spacing and "circuit" configuration of the transformer's pins is critical.

The 0-9V, 0-9V 6VA transformer used in the prototype was purchased from **Maplin** code YJ53H. This has a metric pitch although the rest of the p.c.b. is designed around a 0.1in pitch.

The plastic case is the Verobox 212 and is currently listed, money with order, by **Verospeed (☎ *0703 644555*)**, code 75-1238D and **Maplin**, code LL09K. Other cases can be used, but, as mains is present on the circuit board, it is essential that the two halves of any chosen case can be secured together so that it is impossible to gain access to the interior without the use of a suitable tool.

The printed circuit board for the Auto Nightlight is obtainable from the *EE PCB Service*, code EE779. For added safety, it would be wise to cover the mains carrying copper tracks with insulation tape.

Signal Generator

To obtain the best performance from the *Signal Generator* its a case of purchasing the best quality components you can afford, for instance use one per cent tolerance wherever possible. However the best you can hope to achieve with electrolytic capacitors is about ±20 per cent.

This throws up one particular problem in that the frequency sweep control VR2 must have a large electrical rotation to give a reasonable spread at each end of the front panel scale. The one used in the model has a claimed electrical rotation of 340 degrees.

This control is from the Colvern one watt conductive plastic range and carries the code CP16/001/22. The figure 22 designates the length of spindle. The potentiometer was purchased from **Farnell Electronic Components (☎ *0532 636311*)**, order code CP1601/22-10k.

It is important that the 741S op. amp be used in this circuit. The S-designated 741 has an improved slew rate and full-power bandwidth. To date, the only listing we have been able to find is from **Electromail**, coded 305-995. It is about eight times as expensive as the standard 741.

The 6VA mains transformer is the **Electromail (☎ *0536 204555*)** type 196-303. The two printed circuit boards are available from the *EE PCB Service*, codes EE776 (Main board) and EE777 (PSU) respectively.

Knockerbox

One or two problems have come to light when sourcing components for the *Knockerbox* project. Most of them are only minor and are not likely to cause too much concern.

Having said that suitably powerful 12V solenoids seem to be few and far between and will, as mentioned, be mostly governed by the amount of power/force required to activate your door knocker. The one used in the model is an RS type (code 349-709) and has a claimed coil power of 10W.

The solenoid can be ordered through any *bona fide* RS stockist or obtained direct from **Electromail (☎ *0536 204555*)**, their mail order operation. Other types can be used and it might be worth checking through the new season of catalogues, particularly in the "Bargain" listings section.

The metal frame of this solenoid has M4 tapped fixing holes which allows the metal tab of the power transistor to be bolted to it. The frame then acts as a heatsink.

The 2046 opto-isolator (code 307-979) was also purchased from the same company, but will only be available while stocks last. This is not a problem as it is a general purpose device and most of our advertisers will be able to supply a suitable transistor opto-isolator.

The isolator is a 6-pin d.i.l. device and sits in an 8-pin i.c. socket on the board. Two things to note here is that only six mounting holes have been provided for the i.c. socket and the opto device must sit in the bottom pins of the holder. Pins one and eight of the *holder* should be snipped off or splayed out clear of the board.

Because of the power requirements of this circuit, particularly the solenoid, it is important to use a 30VA mains transformer. The 500k preset potentiometer specified for VR2 seems to be in very short supply and may prove difficult to locate. However, the more common value of 470k should work quite comfortably in this circuit.

Due to the presence of mains voltages, it is essential that a metal case be used and that it is Earthed as indicated. The printed circuit board is available from the *EE PCB Service*, code EE775 (see page 824).

Mind Machine

Looking down the components list for the *Mind Machine*, only two components stand out as devices that will cause local sourcing problems. These are the 5V voltage regulators and the programmable CMOS crystal clock oscillator.

These are both RS components and are available through **Electromail**. The LP2950CZ micropower regulator is coded 648-567 and the EXO-3C programmable crystal cock oscillator is coded 647-075, this is the required 12MHz version.

The printed circuit board for the Mind Machine is available from the *EE PCB Service*, code EE778. See page 824. Finally, please pay special attention to the warning note at the start of the article.

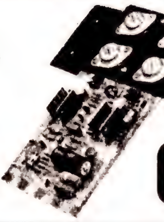
AUTONA LTD

UK's leading module manufacturer since 1972

BUILT AND TESTED **MODULES** **FULL INSTRUCTIONS SUPPLIED**

★★ AUDIO ★★

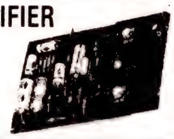
AL12580–125W AMPLIFIER



A rugged, high powered module that is ideal for use in discos & P.A. Systems where powers of up to 125W, 4 ohms are required. The heavy duty output transistors ensure stable and reliable performance. It is currently supplied to a large number of equipment manufacturers where reliability and performance are the main considerations, whilst for others its low price is the major factor. Operating from a supply voltage of 40-80V into loads from 4-16 ohms.

£18.95 + VAT

AL2550–COMPACT LOW-COST 25W AMPLIFIER



One of our most popular audio modules with tens of thousands installed. Ideal for domestic applications where low distortion and compact size are the prime requirements. Used with supply rails of 20V-50V into loads of 8-15 ohms.

£6.55 + VAT

MM100–BUDGET 3-INPUT MIXER

With a host of features including 3 individual level controls, a master volume and separate bass and treble control, it provides for inputs for microphone, magnetic pick-up and tape, or second pick-up (selectable), and yet costs considerably less than competitive units. This module is ideal for discos and public address units and operates from 45V-70V.

£17.49 + VAT

MM100G

As MM 100 with two guitar +1 microphone input intended for guitar amplifier applications.

£17.49 + VAT

★★ SECURITY ★★

MINIATURE PASSIVE INFRA-RED SENSOR–RP33

Switchable Dual range, detects intruders up to 6 or 12 metres

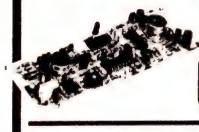
Now only £17.95 + VAT

Discounts start at 3 units.

This advanced sensor operates by detecting the body heat of an intruder moving within the detection field. Slow ambient changes such as radiators, etc. are ignored. Easily installed in a room or hallway. Providing reliable operation from a 12V supply, it is ideal for use with the CA 1382 or equivalent high quality control unit. Supplied with full instructions.

Size 80 x 60 x 40mm

DIGITAL ULTRASONIC DETECTOR–US 5063



Crystal controlled movement detection module operating at 50kHz with an effective range up to 20ft. Suitable for operation in household or vehicle security systems. 12V operation and built-in timing.

£14.93 + VAT

ADVANCED CONTROL UNIT–CA 1382

Easily installed

- ★ *Automatic Loop Test When Switched On*
- ★ *Automatic Siren Re-Set*
- ★ *Audible Entry/Exit Warning Buzzer*
- ★ *Two Separate Loop Inputs +24-hr Circuits*
- ★ *Easily Installed. Full Instructions Supplied.*

This advanced control panel provides effective and reliable control for all security installations, yet its operation is sheer simplicity for all members of the family, and is supplied with two keys. Housed in a steel case with an attractive moulded front panel, it compares with units costing twice the price.

Only £44.95 + VAT

LOW-COST CONTROL UNIT–CA 1250

This tried and tested control unit provides the finest value for money in control systems, with many thousands protecting houses all over the country. A suitable steel enclosure is available separately.

Only £21.35 + VAT

50FT INFRA-RED BEAM–IR1470

The IR1470 consists of a separate transmitter and receiver providing a beam of up to 50ft which, when interrupted, operates a relay in the receiver which in turn may be used to control external equipment. The system requires only 65mA from a 12V supply. Size: (each unit) 82 x 52 x 57mm

£25.61 + VAT

FULL RANGE OF SECURITY ACCESSORIES STOCKED PROVIDING EVERYTHING YOU NEED TO PROTECT YOUR HOME

SEND OR TELEPHONE FOR FREE LITERATURE

Dept EE12, 51 POPPY ROAD
PRINCES RISBOROUGH
BUCKS HP17 9DB
TEL: (084 44) 6326 FAX: (084 44) 7102
Add VAT + £1.50 p&p on all orders. Export add 10%

Callers by appointment only

VISA

UPGRADE OR BUILD YOUR OWN IBM COMPATIBLE

MOTHERBOARDS

CPU	RAM	L/SPEED	PRICE
286-12	0K	**16Mhz**	**£69**
286-16	0K	**20Mhz**	**£79**
386-SX-16	0K	**18Mhz**	**£155**
386-25	0K	**33Mhz**	**£285**
386-33	64K cache	**54Mhz**	**£390**

GRAPHIC CARDS

V.G.A.	512K	16 BIT	**£65**
V.G.A.	1 Mbyte	16 BIT	**£95**

ADD IN CARDS

FDD/HDD	(1:1)	**£49**
I/O CARD 2S,1P,1G		**£28**

BOOKS

Build your own 80286 IBM Compatable	**£17.30**
Build your own 80386 IBM Compatable	**£17.30**
PC Uprade Book	**£12.95**

KEYBOARDS

(ENHANCED 102 KEY)

IBM – COMPATIBLE	**£29**

FLOPPY DRIVES

1.2Mbyte	5.25"	**£42**
1.44Mbyte	3.5"	**£39**

HARD DRIVES

44Mbyte Seagate IDE	**£135**
89Mbyte Seagate IDE	**£235**

CASES

Desktop Case + 200W PSU	**£64**
Minitower Case + 200W PSU	**£74**

MONITORS

14" SVGA Multimode monitor	**£210**

Write, Phone or Fax for a FREE Catalogue

All prices exclude VAT (Carriage at cost)

MANY OTHER PERIPHERALS AVAILABLE

PANRIX ELECTRONICS

93 KENTMERE APPROACH
LEEDS LS14 1JW
TEL: (0532) 650214
FAX: (0532) 323937

OPEN FROM 10am-6pm MON-SAT

VISA

COMPONENTS
For TV ★ Video Audio ★ Computer

VIDEO BELT KITS

AMSTRAD	VCR4600/4700/5200	£3.19
FISHER	FVHP905/906/908	£2.93
JVC	HR3300/3330/3660	£2.79
SANYO	VTC5000/5150/5500	£1.49
SANYO	VTC6500	£2.49
THORN	8900 to 8922	£2.79

VIDEO PINCH ROLLERS

AMSTRAD	VCR4500/4600 Mod Kit	£8.17
HITACHI	VT11/VT33	£5.17
JVC	Above models	£5.17
SHARP	VC381/386/388/390	£5.67
THORN	3V00/06/16/22/23/24	£5.17

SERVICE MANUALS

BINATONE	01/9771	£6.99
PHILIPS	22DC570/670-00	£3.25
PHILIPS	KT4/K40 Chassis	£10.00

OTHER SPARES

FERGUSON	3V23/29/30/32 Reel Idler	£3.55
HITACHI	VT11/14/33/34/61/62/63 Video Head	£26.10
SHARP	RGF281/4 Main belt	£1.40
TOSHIBA	STU2 Mains transformer	£9.99

LEADS & CONNECTORS

'Universal' Video Lead Kit	£7.40
9 piece 'Scart' Video Lead Kit	£8.59
AC Mains – 2pin fig. 8	£0.61

INTEGRATED CIRCUITS

LM733CN	£2.27
TBA530	£1.14
TBA810P	£1.40
TDA1001B	£2.66

AERIALS & EQUIPMENT

FM Omnidirectional Aerial	£18.24
UHF TV Aerial (10 element – Band A)	£6.89
Loft Mast/Bracket	£1.99
75Ω CO-ax Cable*	per m/ £0.23
Cable clips*	per/10 £0.21

*(Brown or White)

TELEPHONE ACCESSORIES

B.T. Plug-in Tone Ringer	£6.95
Socket Doubler	£3.68
IDC Junction Box	£3.95
5m Extension Lead	£4.20
LJU2 Secondary Skt. & Box	£2.30
LJU3 Secondary Skt. (Flush)	£2.67
4 core cable	per/m £0.15
Cable clips	per/10 £0.20

TOOLS & EQUIPMENT

UNIROSS Plug-in 'Fast' Charger for AAA/AA NI-CAD's	£5.49
UNIROSS 'C' Ni-Cad. Battery	£2.09
WELLER WM12D Micropoint Soldering Iron 12W/240Vac	£8.25
'Universal' Crimping Tool	£2.45
Junior Hacksaw	£0.80
Craft Knife & Spare Blade	£0.58

This is just a small sample of stock. Our latest Price List is free on request with first order – Alternatively please send 50p Stamps/Cheq./3xIRC's towards P&P for a copy by return.

WE CAN SUPPLY A VAST RANGE OF SPARES for many makes of TV, Video, Computer & Audio Equipment. **WRITE** (Encl. s.a.e. please) or **PHONE FOR A 'PRICE & AVAILABILITY' on your requirements.** **0452 526883**

COMPUTER SPARES

AMSTRAD/SINCLAIR

IC 40007 G. Array	£19.86
IC 40010 G Array	£18.86
IC AY38912A	£6.32
IC HA13408	£7.67
IC HD6845SP	£15.18
IC LA4140	£1.70
IC PEGA1A	£30.85
IC UPC1378H	£2.45
IC Protector N75	£1.55
Transistor 2SD1397	£4.99
Jack Skt. (CPC I/O)	£2.07
Joystick (CPC)	£6.71
Service Manual CPC 464 (early)	£8.49
Service Manual PCW8256/8512	£13.89
User Manual CPC464	£10.95
User Manual CPC6128	£14.25

ATARI

IC CO14806 (XE/L)	£11.40
IC CO29947 (XE/L)	£4.49
IC YM2149F (ST)	£10.02
SWITCH 'Reset' (ST)	£1.25
THERMISTOR (ST-PSU)	£1.34
TL431 (ST-PSU)	£1.20
CNY65 (ST-PSU)	£4.42
PC101 (ST-PSU)	£4.73
PC713V (STE-PSU)	£2.94

We can supply most ST-PSU Transistors

PHILIPS

Serv. Manual BM7513	£2.99
Serv. Manual	£3.80

EPSON

C78010BD031 CPU	£30.24
HA13007 T. Array	£4.66

SINCLAIR

40054 ROM	£16.99
40056 (128K/ +2)	£17.99
ROM (48K/ +)	£7.99
ZX8302 (QL)	£10.48
ZX8401 (Spec.)	£7.94
ZTX213 Transistor	£0.28
ZTX650 Transistor	£0.49
UM1233 Modulator	£6.56
Membrane (QL)	£7.95
Membrane (Spec.48K)	£4.50
Membrane (+/128K)	£7.99
Bubble Mat (+/128K)	£1.18
Speaker (+/48K)	£1.49
Power Skt. (Spec.)	£0.65
28 way Edge Conn	£3.49

COMMODORE

IC 6510 CPU	£10.03
IC 6526 CIA	£11.11
IC 6569 VIC	£25.63
IC 6581 SID	£16.35
IC 8501 CPU	£10.80
IC 8520 CIA	£11.22
IC 251641-02 PLA	£3.98
IC 906114-01 PLA	£9.24
IC 901225-01 ROM	£6.55
IC 901226-01 ROM	£9.24
IC 901227-03 ROM	£12.33
Modulator 2519160-02	£18.76
User Manual (C64)	£4.25
TV Lead (Also Spec.)	£1.49

All above are manufacturers original spares. We can also supply a range of manuals and parts for some other makes – including Acorn, Olivetti & Panasonic.

OTHER COMPUTER CHIPS

6502 CPU	£5.05
6522 VIA	£4.49
6818 RT Clock	£7.24
8255A PPI	£2.82
8272A FDC	£14.09
AM26LS31PC	£1.63
75154PC 4xline driver	£1.85
64Kx1 DRAM (120ns)	£1.99
64Kx1 DRAM (150ns)	£1.69
64Kx4 DRAM (100ns)	£2.99

SPECIAL OFFERS

SONY High Speed CPU (8MHz) – Same as NEC V30 Direct replacement for 8086 CPU (Approx. 25% faster) **£9.99** While stocks last.

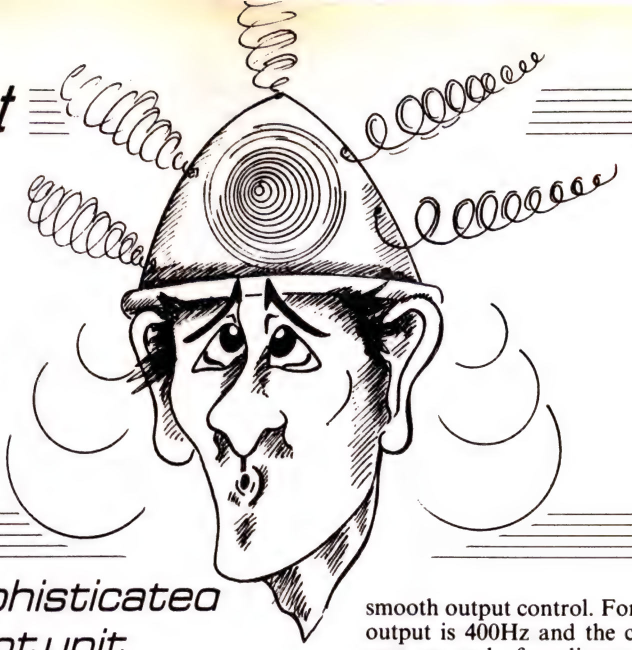
74LS00 TTL IC ...... **18p** ea. (1+)
...... **15p** ea. (5+)

TEXAS DRAM (TMS4532-15NL4) - For Spectrum 48K
...... **£1.72** ea. (1+)
...... **£1.22** ea. (5+)

MAIL ORDER ONLY. Please add 95p (UK) P&P but not VAT. All items subject to availability – Prices can change without notice.

MARAPET (EEM)
1 HORNBEAM MEWS
GLOUCESTER GL2 0UE

Constructional Project



MIND MACHINE

ANDY FLIND

Learn to relax with this sophisticated programmable Entrainment unit.

In the *Brainwave* project (Sept '91), the design of a simple mind "entrainment" project was given, and the principles of this relaxation technique were described. Although an effective first project for newcomers to this field, the unit was very simple, and a far more sophisticated instrument can be built.

The next two articles in this series will cover the construction of an advanced version of the *Brainwave* unit. The Mind Machine combines "photic stimulation" and "binaural" sound, and has the optional facility of a programmer so that users can experiment with various sequences.

Photic stimulation, the flashing of lights in the user's eyes at the desired brainwave frequency, is the most effective entrainment method. Sound is the next most popular, various types of noise being available from instruments sold in the States.

White or pink noise is common, modulated in time with the lights, but the designer tried this and found it irritating! Plain synthesized "surf" sound is better.

HEMI-SYNC

The most effective sound is undoubtedly that termed "Hemi-sync" or "Binaural". This consists of two audio tones, nominally about 400Hz, but differing by the entrainment frequency in use. For instance, for "Alpha", the lights might flash at 11Hz with one tone at 400Hz, whilst the other would be 11Hz lower at 389Hz.

Played together through loudspeakers these tones would produce the familiar "beat note" but, played one to each ear with headphones, the effect is different. It is perceived as a sort of bell-like tone, not at all unpleasant or monotonous as might be expected.

Meanwhile, the theory is that, in synthesizing the "beat note" internally, the brain rapidly settles into it's own internal rhythms at the same frequency. It has also been suggested that this technique encourages synchronisation between the brain's two hemispheres.

The author's personal experience is that, whilst not as powerful as light stimulation, such sound has a useful enhancing effect when synchronised and combined with it.

CLOCK OSCILLATOR/ DIVIDER

At first sight, it seems all that is necessary to create the tones is a pair of audio oscillators. In practice this isn't so, because at such close frequencies they tend to "pull" together, becoming unstable, and precise and repeatable control of the frequency difference is very difficult.

After some fruitless attempts with phase-locked loops, a simple and effective circuit was devised however. A single high frequency "clock" oscillator drives two dividers. One simply provides a fixed audio frequency, but the other blocks it's own input briefly each time the output changes state, so the end frequency is a fraction lower.

This technique avoids the "pulling" and instability inherent in the use of two oscillators. The only snag is that a high clock frequency is necessary for reasonably smooth output control. For example, if the output is 400Hz and the clock is blocked once per cycle, for adjustment steps of 1Hz the clock must be 160kHz.

In practice better resolution than this is desirable and a clock in excess of a megahertz is needed. This caused difficulties as this part of the circuit operates from a five volt supply and most simple oscillator circuits proved unreliable at this frequency and voltage.

The solution came in the form of a CMOS crystal oscillator-divider type EXO-3C. Intended for five volt supplies, this can produce a precise 1.5MHz signal. Supplied in an 8-pin d.i.l. package, it needs no external components other than a 100n decoupling capacitor.

CIRCUIT DESCRIPTION

In the complete circuit diagram of the Mind Machine, Fig. 1, IC1 is the clock oscillator. IC2 divides it by 4096 to give an output of 366Hz, close to the desired 400Hz. The clock output also goes to the second divider IC4 through resistor R5, and so can be gated by pulling low.

Voltage control of the gating period was needed for later use with a programmer. This is achieved with dual comparator IC3, which operates as follows.

The output of each comparator in IC3 is an open-collector transistor, not a bi-directional source like an op-amp. When an inverting input of one of these is *higher* than the non-inverting, the output can sink a current to ground, pulling any voltage present low. When the inverting input is *lower*, the output is effectively open-circuit. A signal for this part of the circuit is taken from pin 15 of divider IC4, one stage before the output pin 1.

WARNING NOTICE

Photic stimulation at Alpha frequencies can cause seizures in persons suffering from Epilepsy. For this reason such people MUST NOT try this project.

A user who is not a known epileptic, but when using the "Mind Machine" begins to experience an odd smell, sound or other unexplained effect, should turn it off immediately and seek professional medical advice.

Because of the above possibility the Mind Machine should not be used while on your own.

YOU MUST TREAT THIS UNIT WITH DUE RESPECT.

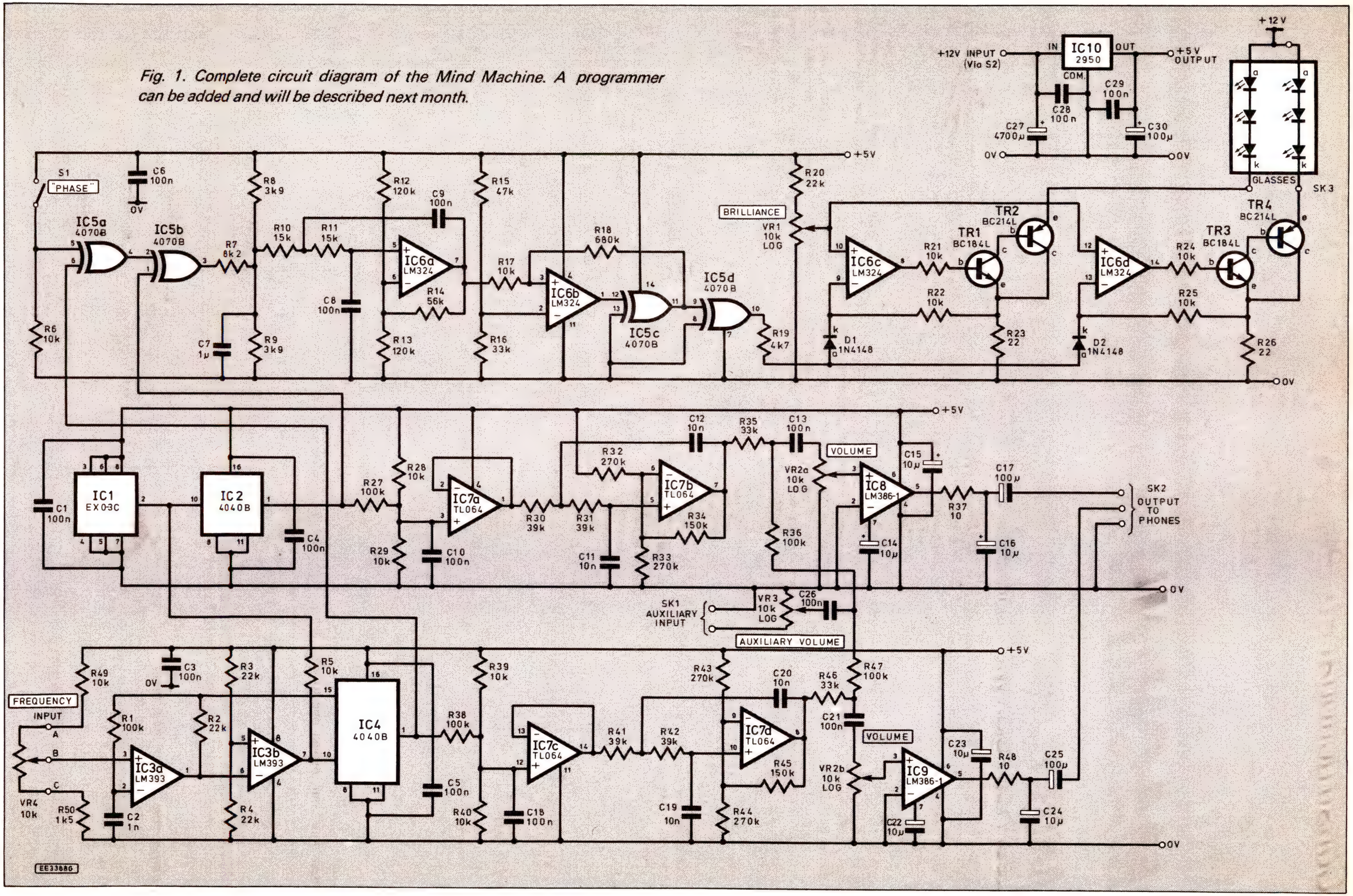


Fig. 1. Complete circuit diagram of the Mind Machine. A programmer can be added and will be described next month.

The non-inverting input to IC3b is held at half the supply voltage. Whilst the inverting input is low, the output will be open circuit so the divider will be clocked. When the signal from IC4 pin 15 goes high, IC3b's output will block the clock by pulling it low.

At the same time, the high signal from IC4 charges capacitor C2. When the voltage across this exceeds the control voltage applied to the input at "B", IC3a's output will pull the input to IC3b low again and the clock will continue. Thus, the higher the control voltage, the longer each break in the clock, so the higher the difference between the output frequencies from IC2 and IC4.

Most readers will know that a square-wave signal sounds horrible! As the project is intended to promote relaxation, the divider outputs are shaped into almost pure sine-waves by two third-order filters constructed around IC7.

OUTPUT AMPLIFIER

The choice of output amplifier was unusually critical with this project. A pure sinewave of fairly low frequency sounds relatively quiet, so reasonable output power is needed.

However, the least bit of distortion or noise is far more obtrusive and annoying than with music or speech. This means that excellent quality is needed in these stages, and several apparently suitable stereo amplifier chips failed to satisfy. They just did not sound "clean" enough.

The LM386 gave the best results, the only problem being that two separate amplifiers, each with a number of electrolytics, are needed. Even these needed a measure of output damping to remove the last traces of noise.

An auxiliary input is included for users who wish to experiment with the mixing injection of other sounds such as surf, pink noise, soft music or possibly even a self-hypnotic tape!

L.E.D. DRIVER

The signal for the l.e.d. drivers is derived from the two divider outputs. Although it would appear possible to extract it digitally, in practice this causes unacceptable "jitter", so an EX-OR gate, IC5b, followed by a third-order filter stage IC6a, is used.

During testing, some headphones used proved to be connected in anti-phase! Because of this, and to allow for experimenting with the phase of the lamps relative to the sound, Phase switch S1 was included. Closing it inverts the phase.

The output from filter IC6a is a triangle wave of reasonable linearity. As explained in September's *Brainwave* article, the l.e.d.s should be driven with a duty cycle of about 25 per cent "on" time, as this allows them to be overdriven to increase brilliance.

In this circuit the required duty cycle is obtained by switching at the appropriate points of the triangle wave. In fact, the positive section of the input signal turns the l.e.d.s "off".

As with the *Brainwave* circuit, the l.e.d.s are normally "on", their brilliance being set by the "log" law potentiometer VR1. The signal from IC5d passes through diodes D1 and D2 to force the IC6c and IC6d inverting inputs high, causing their outputs to go low and turn off the lights. A small amount of positive feedback is provided through resistor R18 to ensure clean switching.

There is one difference in the output stages from those of the previous design, this being the inclusion of an extra transistor in each. If the glasses are unplugged from the *Brainwave*, the op-amps will see an error in the sensed output current, and will force base current into the output transistors in an effort to correct the situation. The only limit to this current is the op-amp output current limiting circuitry.

Whilst not a serious problem, it was decided to eliminate it in this design. If the glasses are unplugged with this circuit, the op-amps will still try to correct or compensate, but the base currents will be limited by the 10k resistors R21 and R24. The current that can be supplied through these two resistors will not be enough to operate the l.e.d. driving transistors directly though, so the inclusion of transistors TR2 and TR4 overcome this.

POWER SUPPLY

A 12V battery supply allows the use of three l.e.d.s for each eye. A large decoupling capacitor, C27, reduces the likelihood of heavy l.e.d. currents causing unwanted noises in the audio output, whilst IC10 supplies a 5V regulated rail for everything except the l.e.d.s.

The regulator specified is a micropower type with greater accuracy and a lower "drop-out" voltage than the standard 78 series.

COMPONENTS

See SHOP TALK Page

Resistors

R1, R27, R36, R38, R47	100k (5 off)
R2, R3, R4, R20	22k (4 off)
R5, R6, R17, R21, R22, R24 R25, R28, R29, R39, R40, R49	10k (12 off)
R7	8k2
R8, R9	3k9 (2 off)
R10, R11	15k (2 off)
R12, R13	120k (2 off)
R14	56k
R15	47k
R16, R35, R46	33k (3 off)
R18	680k
R19	4k7
R23, R26	22 (2 off)
R30, R31, R41, R42	39k (4 off)
R32, R33, R43, R44	270k (4 off)
R34, R45	150k (2 off)
R37, R48	10 (2 off)
R50	1k5

All 0.6W 1% metal film

Potentiometers

VR1, VR3	10k rotary carbon, log.
VR2	10k dual (stereo)-ganged rotary carbon, log.
VR4	10k rotary carbon, lin.

Capacitors

C1, C3, C4, C5, C6, C8, C9, C10, C13, C18, C21, C26, C28, C29	100n polyester (14 off)
C2	1n polystyrene
C7	1μ polyester
C11, C12, C19, C20	10n polyester (4 off)
C14, C15, C16, C22, C23, C24	10μ radial elect., 50V (6 off)
C17, C25, C30	100μ radial elect., 10V (3 off)
C27	4700μ radial elect., 16V

Semiconductors

D1, D2	1N4148 signal diode (2 off)
TR1, TR3	BC184L *npn* silicon transistor (2 off)
TR2, TR4	BC214L *pnp* silicon transistor (2 off)
IC1	EXO-3C programmable CMOS crystal clock oscillator (12.0MHz)
IC2, IC4	4040B CMOS 12-stage divider (2 off)
IC3	LM393 dual comparator
IC5	4070B CMOS quad "Exclusive-OR" gate
IC6	LM324 quad op-amp
IC7	TL064 quad low-power op-amp
IC8, IC9	LM386-1 audio amplifier (2 off)
IC10	LP2950CZ 5V regulator

Miscellaneous

S1	Miniature s.p.s.t. slide switch
S2	Miniature s.p.s.t. On/Off toggle switch
SK1	Mono ¼ in. jack socket and plug (Aux)
SK2	Stereo ¼ in. jack socket and plug (Headphone)

Plastic case with aluminium front and rear panels, Vero 202-21035F, size 205mm x 140mm x 75mm; 8-pin d.i.l. socket (4 off); 14-pin d.i.l. socket (3 off); 16-pin d.i.l. socket (2 off); 3-pin DIN plug and chassis mounting socket; 5mm ultrabright (500 mcd) l.e.d. (6 off); swimming goggles for "glasses"; control knobs (4 off); 8-cell battery holder and batteries; "Walkman" type miniature headphones, without headband; connecting wire; solder etc.

Printed circuit board available from the *EE PCB Service*, code EE778.

Approx cost guidance only **£32** *plus case*

CONSTRUCTION

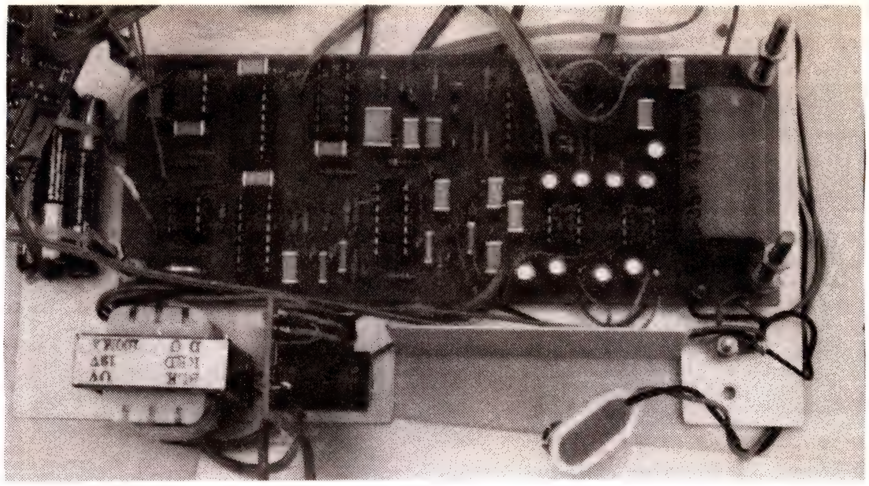
Most of the components of this project are mounted on a single printed circuit board, construction of which should present no special problems. This board is available from the *EE PCB Service*, code EE778.

The component layout and full size copper foil master pattern is shown in Fig. 2. There is a single wire link to fit, after which the components should be fitted in order of physical height.

With the exception of IC10, d.i.l. sockets are strongly recommended for all i.c.s, the insertion of which should be left until testing is carried out. IC10 should be the last soldered component to be fitted, as it is a CMOS device and this will keep the risk of static damage to a minimum.

The polyester capacitors should all be of the silver-coloured miniature layer type, which should fit correctly onto the board. Take care with the polarity of the electrolytics and diodes, and with transistor types since two are *npn* and two *pnp*.

Most of the resistors are mounted horizontally, but a few are vertical to suit the layout and keep the board size to a minimum. Solder pins are recommended for external connections as these make testing and wiring easier.



The Mind Machine p.c.b.

TESTING

A board of this complexity should be tested in logical steps. Fortunately, this project's circuit design makes this quite simple. An oscilloscope is useful for some tests, but constructors without access to one need not be deterred as a most sections can be effectively verified as operating correctly using just a meter.

Hopefully, sockets will have been used for IC1 to IC9, so the initial test is to power the board without any of the i.c.s fitted, and check the 5V regulated supply. A good place to find this is on the top of capacitor C29. There will be an initial surge of current as the capacitors charge, in particular C27, after which the supply current should settle to a very low value, no more than a milliamp or two.

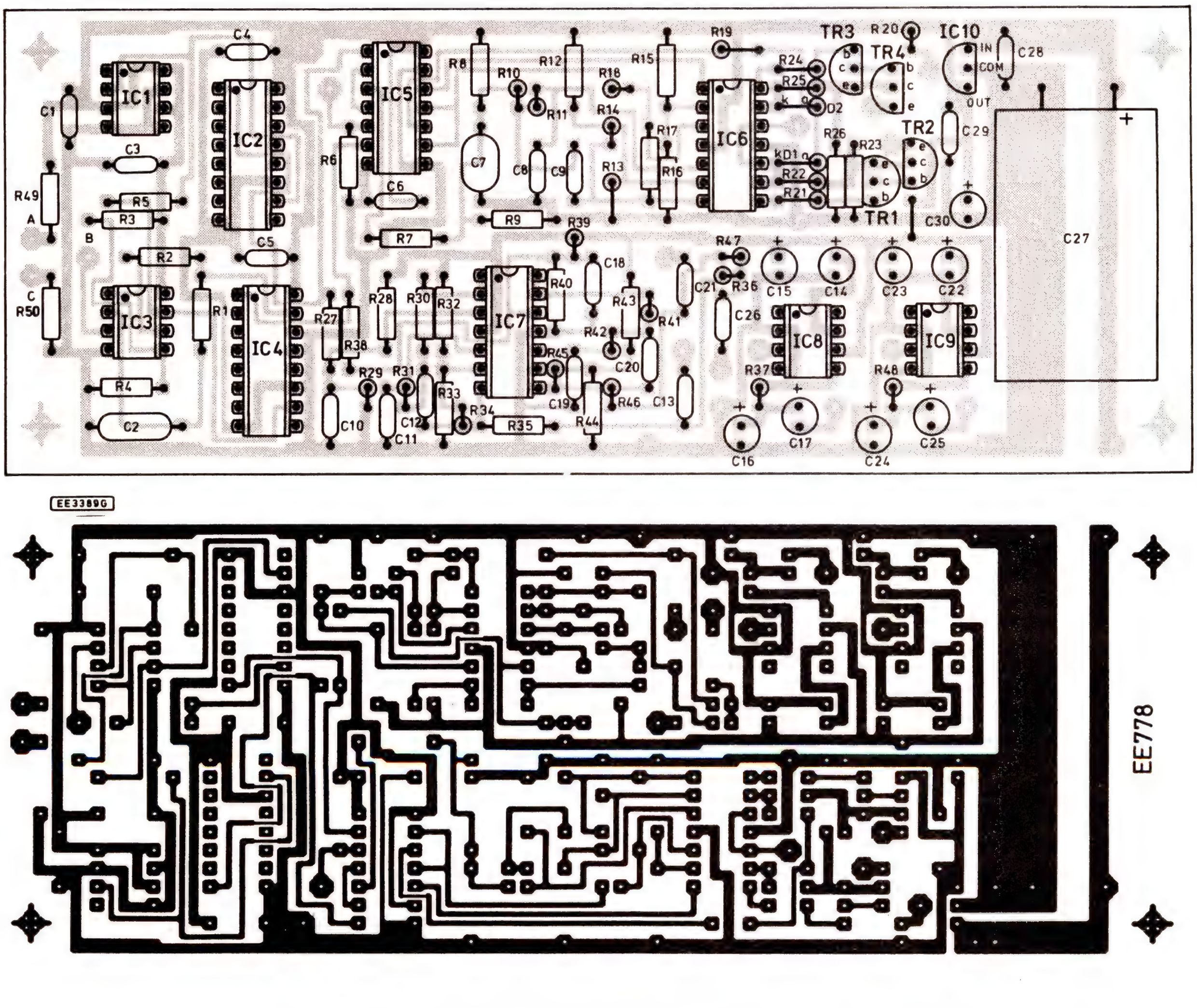


Fig. 2. P.C.B. layout and wiring for the Mind Machine.

The negative supply rail is used as the reference for all tests. The power should always be turned off when fitting i.c.s or making connections other than test gear.

If the regulated supply is working, the oscillator IC1 should be inserted on the board, and it's output, at pin 2, checked. A 'scope should show a 1.5MHz squarewave, but if this is not available a meter should show the average d.c. value of the output as 2.5V. If this is present, it's a virtual certainty that the oscillator is operating.

The two dividers IC2 and IC4 can be fitted next. Without IC3, IC4 has an uninterrupted clock signal. Again, a scope should show their 366Hz squarewave outputs, or a meter should show the average value of 2.5V. The output of each will be found at pin 1.

Assuming this is OK, IC7 is next, to complete the two filters. These should have sinewave outputs at pins 7 and 8. Peak-to-peak values seen on a scope are around 0.5V, or a DVM (Digital Volt Meter) on an a.c. range should show the r.m.s. value of about 0.2V. Again, the d.c. level should be about 2.5V, though this time it doesn't indicate presence of the signal. The supply current up until this point should be very low, no more than 5mA.

The volume control VR2 can now be temporarily connected and IC8 and IC9 plugged in, one at a time. These too should have about 2.5V d.c. at their outputs, pin 5, whilst the signal, as seen at each headphone output with VR2 at maximum, should be about 2.5V peak-to-peak on a scope or about 0.8V r.m.s. on a meter.

If all is fine so far, the headphone socket should be hooked up and the 'phones plugged in. At this point the frequencies will be identical, so the sound will be apparently "mono". It should, however, be very smooth and pure. Depending on the surroundings of the board on test, there may be some induced hum, but this will not be a problem after final assembly.

If VR4 is now connected to the board and IC3 fitted, the "binaural" sound effect should be audible on the phones, with the frequency of the "beat" adjustable from about two to twenty hertz. The supply current will now depend upon the volume setting. To some extent this is the case even if the headphones are not plugged in, as when the control is turned well up current flow through capacitors C16 and C24 will be apparent.

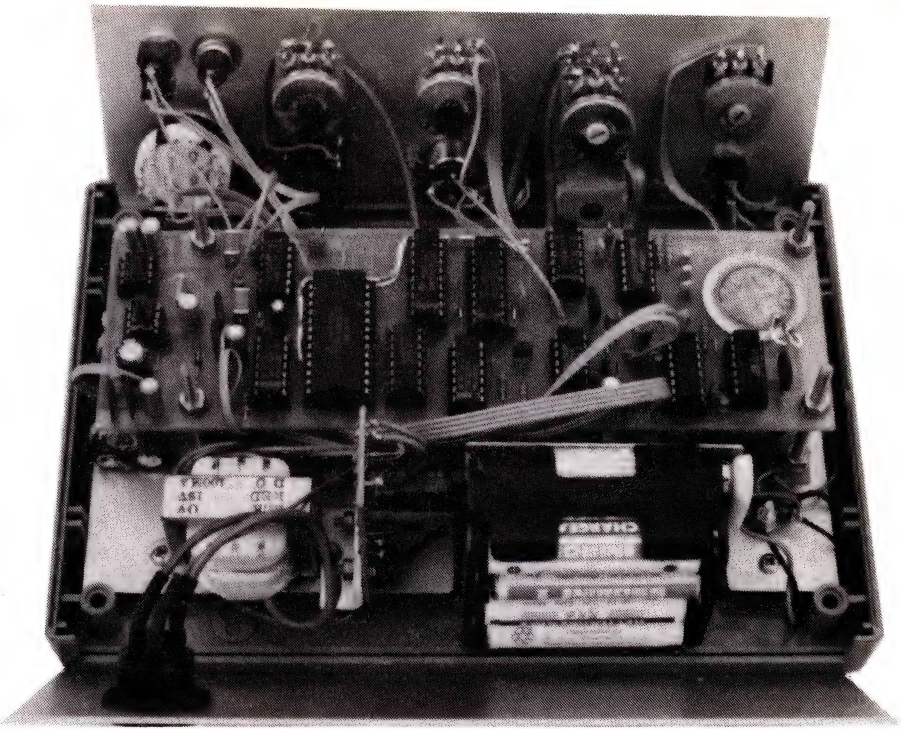
LIGHTING UP TIME

With the oscillators and sound processing working, attention can be turned to the "lights" part of the circuit. IC5 and IC6 can now be fitted.

With VR4 set to minimum frequency, if the output at IC5 pin 10 appears mostly positive, pulsing low at about two hertz, this part of the circuit is probably satisfactory. At a higher frequency setting the apparent average d.c. voltage at this point should be around 3.8V.

If there are problems in this area, it may help to know that there should be average d.c. levels of 2.5V at IC5 pin 4 and pin 3, and at IC6 pin 7. At low frequencies a flicker should be visible at IC5 pin 3 and IC6 pin 7. A scope should show a triangle wave of about two volts peak-to-peak at IC6 pin 7, but don't bother trying this at IC5 pin 3 where the signal consists of 5V peak-to-peak pulses of constantly varying width!

Finally, VR1 can be hooked up, an l.e.d. placed across each l.e.d. output point, and VR1 checked for controlling their brilliance correctly. The frequency control VR4 should adjust their flicker rate from about two to twenty hertz.



The complete unit with programmer p.c.b. and charger – see text.

The total supply current will now depend on volume and brilliance of the outputs. With both at a minimum, it will be about 20mA-25mA. At full power on both, it will be in the order of 80mA-90mA.

CASE

It was felt that this project deserved a smarter case than the grey boxes that have graced many of the author's designs so a smart grey and white Verobox, size 205mm x 140mm x 75mm, was purchased. A "tilt leg assembly" added a nice finishing touch, but is not essential.

An aluminium "screening chassis" was made and fitted to the moulded bosses in the base of the box with the self-tapping screws provided. The other components of the project are mounted on this.

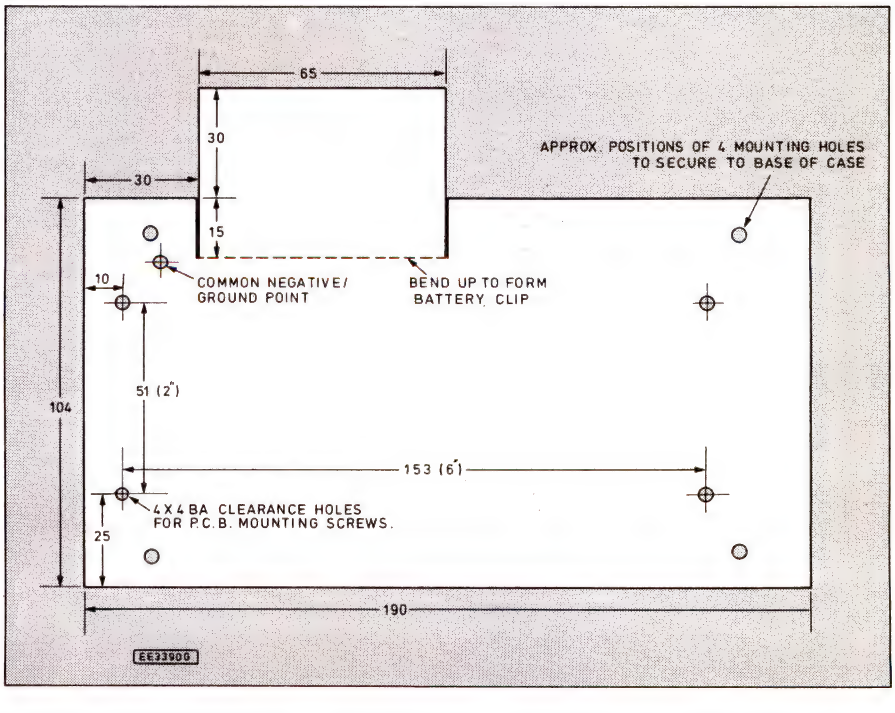
At the back of the plate a section is cut and bent up to secure the battery pack by pressing it against the aluminium back of the case. A drawing of this plate appears in Fig. 3, and the general layout of the various parts inside the case is shown in the photographs and Fig. 4.

The batteries are housed in an eight-cell plastic holder, connecting to the circuit through a PP3-style clip. Some masking tape prevents the metal parts of the holder touching the metal plate.

BOARD MOUNTING

The circuit board is mounted on four 50mm (2 in.) brass 4BA screws projecting

Fig. 3. Metal screening chassis details.


65
30
30
15
10
104
51 (2")
153 (6")
25
190
APPROX. POSITIONS OF 4 MOUNTING HOLES TO SECURE TO BASE OF CASE
COMMON NEGATIVE/ GROUND POINT
BEND UP TO FORM BATTERY CLIP
4 X 4 BA CLEARANCE HOLES FOR P.C.B. MOUNTING SCREWS.
EE33900

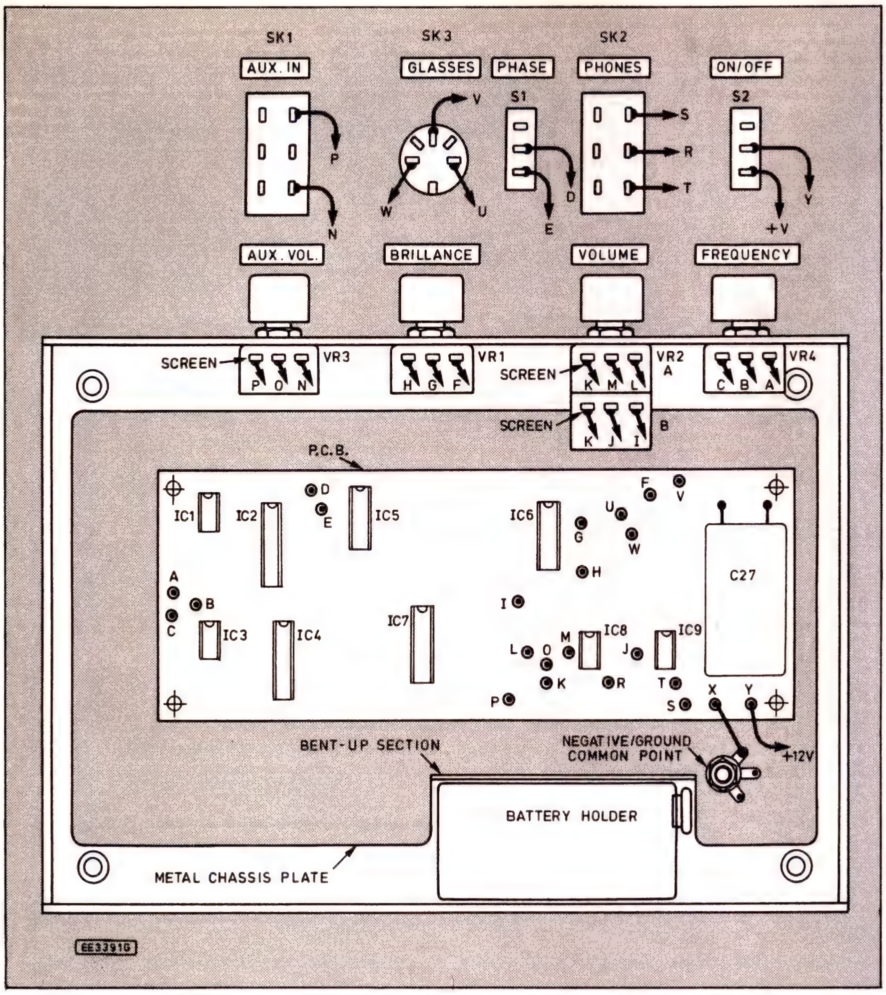


Fig. 4. Interwiring of the front panel mounted components and the p.c.b. Only those sockets and controls that relate to this part are shown.

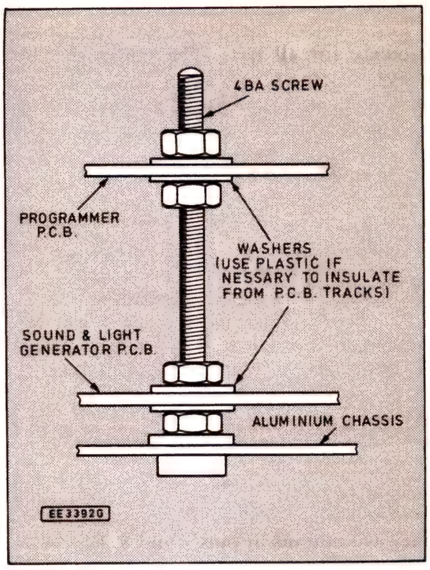

4BA SCREW
PROGRAMMER P.C.B.
WASHERS (USE PLASTIC IF NESSARY TO INSULATE FROM P.C.B. TRACKS)
SOUND & LIGHT GENERATOR P.C.B.
ALUMINIUM CHASSIS
EE3392G

Fig. 5. Mounting the two p.c.b.s (programmer p.c.b. will be described next month).

up from the chassis, detail of one of these is shown in Fig. 5. Some plastic washers are needed to ensure the fixing nuts are insulated from the copper tracks of the board, these being cut from a redundant credit card!

The board is placed low on the screws, to obtain the screening effect of the chassis plate below the audio amplifiers. The reason for the extra length of the screws is that the programming board, to be described next month, is fitted above the present one.

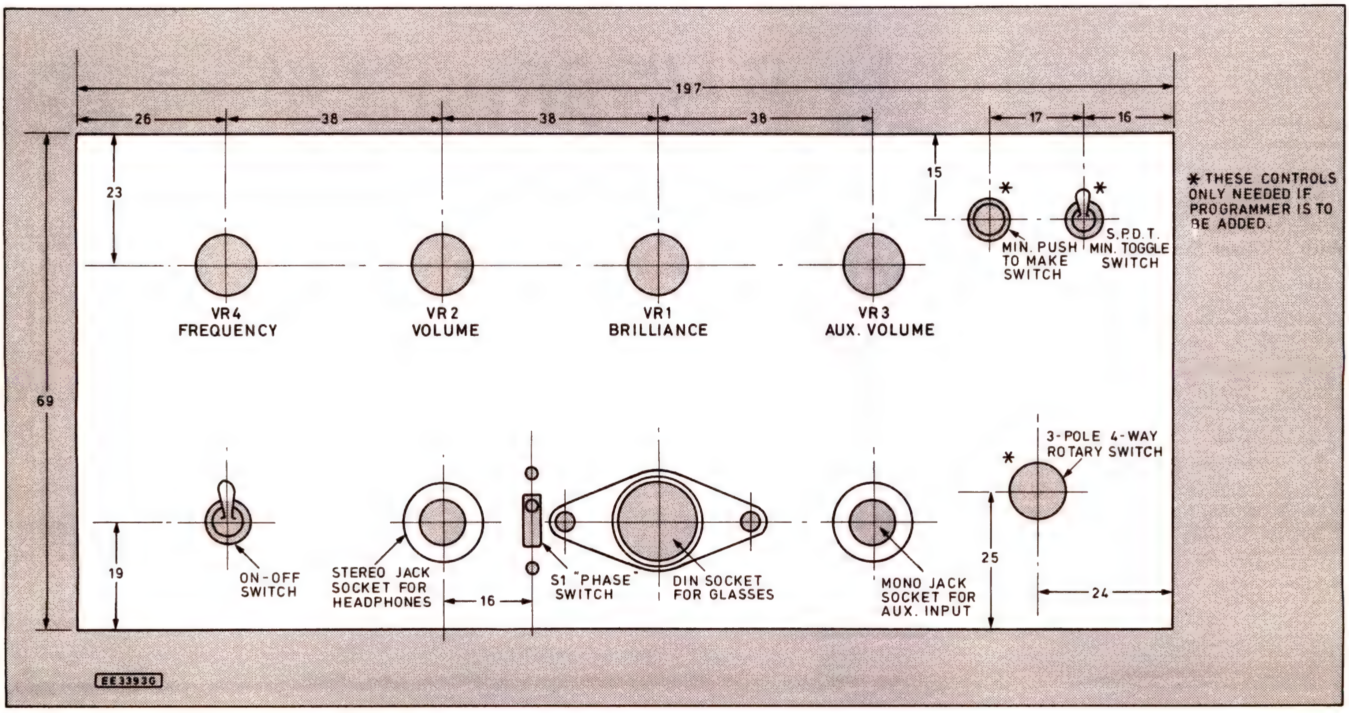
The front panel layout is shown in detail, Fig. 6, as the components fit onto this with little space to spare. Some holes shown will not be needed unless the programmer is added. It should be borne in mind that some of the clearances in the box are on the tight side, so it might be wise to check that the components you have will actually fit before cutting and drilling either this panel or the chassis plate.

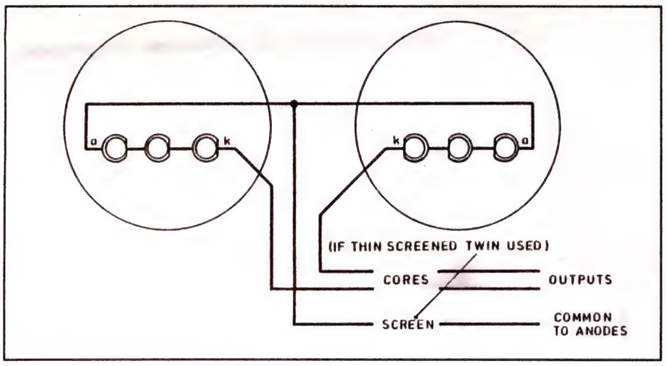
As the front panel is aluminium and earthed to the negative rail, the controls, sockets and so forth must NOT make contact with it. The headphone and auxiliary input sockets are standard ¼ in. types, as these are easier to obtain in plastic insulated form. The miniature headphones recommended are used with an adaptor. A 5-pin DIN socket provides the outlet for the l.e.d. lead.

External connections to the circuit board are shown in Fig. 4. Not shown is the "grounding" arrangement of the metalwork. The battery negative is connected to the point marked on the chassis plate drawing in Fig. 3, then all other negative supply connections are taken from this. Also, a wire is taken from here to the aluminium front plate, using a solder tag placed under one of the DIN socket mounting screws.

This arrangement reduces the possibility

Fig. 6. Front panel drilling details.


197
26
38
38
38
17
16
15
23
69
19
16
25
24
*
*
* THESE CONTROLS ONLY NEEDED IF PROGRAMMER IS TO BE ADDED.
MIN. PUSH TO MAKE SWITCH
S.P.D.T. MIN. TOGGLE SWITCH
VR4 FREQUENCY
VR2 VOLUME
VR1 BRILLIANCE
VR3 AUX. VOLUME
3-POLE 4-WAY ROTARY SWITCH
*
ON-OFF SWITCH
STEREO JACK SOCKET FOR HEADPHONES
S1 "PHASE" SWITCH
DIN SOCKET FOR GLASSES
MONO JACK SOCKET FOR AUX. INPUT
EE3393G



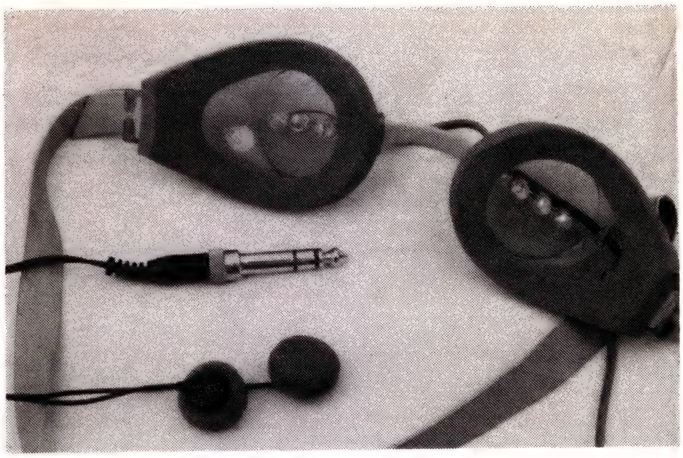


Fig. 7. Wiring of the l.e.d.s mounted in swimming goggles. The photograph shows the finished goggles.

of annoying clicks and pops on the audio due to currents flowing around "earth loops" in the circuit, and provides adequate screening to prevent hum pickup by the amplifiers. Hookup wire or, for greater neatness, ribbon cable, is fine for most connections, but those to the volume controls VR2 and VR3 should be made using *screened* lead.

Standard "AA" cells can be used, but the prototype is fitted with rechargeables and a built-in charger, details of which will be given next month. This avoids the need to dismantle the case from time to time to replace the batteries.

Three "AAA" cells may be visible in the photographs. As will be explained next month, these retain program memory when the instrument is switched off. They should not need replacing more than every couple of years or so.

GLASSES

The glasses are similar in construction to those used with the *Brainwave* project, using three ultrabright l.e.d.s in each lens. They are constructed from swimming goggles with the lenses drilled to take the l.e.d.s, connections for which are shown in Fig. 7.

The goggles are good quality types, with soft foam edging for comfort. Their lead is thin screened twin, with one core each to the l.e.d. cathodes and the screen acting as common for the anodes. This provides a neat, thin and flexible connection.

The headphones can be the cheapest available, as they are required only to play a single tone of medium frequency. "Walkman" phones, the sort that fit right inside the ear without a headband, are recommended as these will not tangle with the glasses as other types tend to.

IN USE

The use of this project is not going to be covered in depth as the principles of "entrainment" were described in detail in the September '91 Brainwave article. The warning for anyone who even remotely suspects they may be epileptic is just as important for this project of course, see the caution notice!

The unit should be used with the **eyes shut.** The light intensity should be set to a comfortable level, and the frequency adjusted until it feels "right". It can then be gradually lowered to produce a sensation of deep relaxation.

The controls are fairly self-evident, save for the phase reversal switch S1. If the frequency is turned right down the two headphones held close to one ear, the sound will be heard as the familiar "beat" note. It will be loudest when the two tones are in phase, and this is when the lights should flash.

If your phones are wired out of phase, as happened to the designer, this switch (S1) will correct matters. You may also like to experiment with reversed phase – it might prove more effective for you.

As a brief recap, the brainwave frequencies this machine can be used to stimulate range from : ***Delta***, 2Hz to 4Hz, the rhythm of deep sleep; ***Theta***, 4Hz to 7Hz, for vivid imagery and creativity; ***Alpha***, 7Hz to 14Hz, relaxed awareness; up to ***Beta***, 14Hz upwards, which is the normal "wide-awake" pattern.

Before the Programmer was fitted the designer would start at high Alpha, and gradually reduce it almost to Delta before slowly bringing it back up again. A brief burst of Beta was occasionally useful before rejoining the real world!

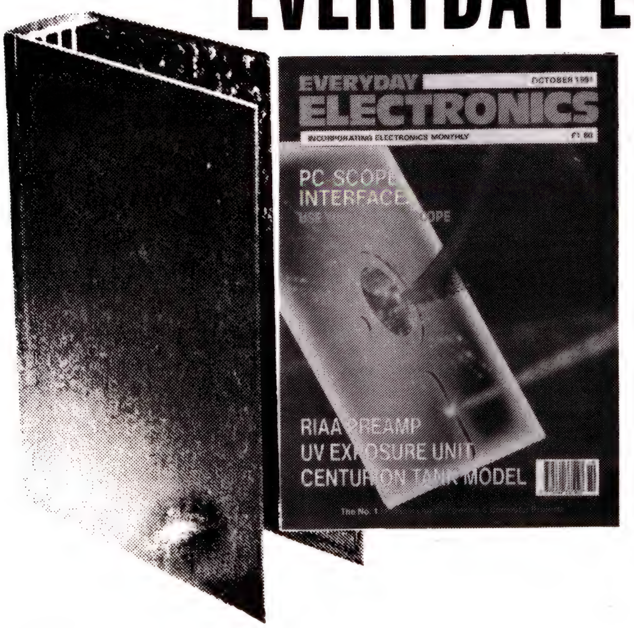
SHORT SESSIONS

It will be found that the effect of this project, with the addition of sound, is far more powerful than lights alone. If you're new to entrainment, it is suggested that initial sessions are kept fairly short, say fifteen minutes, and the Volume and Brilliance are not turned up too far.

The auxiliary input can be used to inject anything desired, pink noise, surf sounds, soft music, or a hypnotic "self-improvement" tape, if you're into that sort of thing. It might even prove to be the most effective tool for giving up smoking ever devised!

Seriously, the author, and most other people who have tried the prototype, found it very relaxing, just the thing for this stressful age.

Next Month: A Programmer Board.



EVERYDAY ELECTRONICS BINDERS

Don't let your valuable issues of EE get binned, burned or bitten (by the dog). Get one of our exquisite orange hard-back binders, slip each issue into it as you get them and you will always know where they are– we hope!

Binders to hold one volume (12 issues) are available from Everyday Electronics, 6 Church Street, Wimborne, Dorset BH21 1JH for £5.95 (£6.95 to European countries and £9.00 to other countries, surface mail) inclusive of postage and packing. **Payment in £ sterling only please. Visa and Access (MasterCard) accepted, minimum order value £5.**

Binders are normally sent within seven days of receipt of your order but please allow up to 28 days for UK delivery – more overseas.

The ONE STOP Component Shop

STOP

- Massive Stocks
- Every kind of component available
- Latest Semi-conductors & Transistors Available from All Over the World
- Credit Card Telephone Orders a Speciality

The new long awaited **160-page Cricklewood Catalogue** will be available **FREE** banded to the January 1992 issue of Everyday Electronics

CRICKLEWOOD ELECTRONICS

Access
AMERICAN EXPRESS
VISA

CREDIT CARD TELEPHONE HOTLINES
Tel: 081 452 0161 & 081 450 0995
40 Cricklewood Broadway, London NW2 3ET
Fax: 081 208 1441 Telex: 914977 CRICKEL G

Hills

HILLS COMPONENTS
established since 1973

can offer the trade a selection of nearly 4,000 product lines covering the following ranges

Aerials & Accessories
Batteries & Accessories
Cables & Accessories
Computer Accessories
Connectors (all types)
Electronic kits/Modules
Filters/Fuses
Hardware/Fixings
Headphones/Intercoms
Connecting leads (all types)
Microphones
Multimeters
Passive Components
P.C. Boards
Relays
Speakers
Switches
Service Aids
Soldering Equipment
Telephones & Accessories
Transformers

TRADE ENQUIRIES ONLY
Please phone or write quoting your company name & address for a copy of our 1991 catalogue

TRADE ONLY

Hills

ELECTRONIC KITS & MODULES

FOR HOBBYISTS ELECTRONICS ENTHUSIASTS
EDUCATIONAL ESTABLISHMENTS ETC.

Build your own:
Geiger-Meuller Indicator, Metal Detector, Stereo Amplifier, Digital Combination Lock, or any of the many other kits available for numerous applications

Each kit comes in component form with easy to follow instructions for assembly

OVER 100 KITS TO CHOOSE FROM
Some of the popular kits include

✱ Antenna Amplifiers ✱ Lie Detectors ✱ Alarm Systems & Monitors
✱ Infra-Red Light Barriers ✱ Sirens – Kojak-Warship-FBI-Ships-Space
✱ Micro-Wave Indicators ✱ Radios & Receivers ✱ Electronic Barking Dog
✱ Lighting Consoles ✱ Amplifiers (up to 200w) ✱ Car Aerial Amplifiers
PLUS MANY MANY MORE

Call us now for details of your local Stockist

HILLS COMPONENTS LTD
Units 5 &6
Melinite Industrial Estate
Brixton Road, Watford
Herts WD2 5SL
0923 52000

SIMPLE MODEL SERIES SPECIAL EASIWIRE OFFER

FREE EASIWIRE IF YOU BUY ANY FOUR MODEL KITS OR EASIWIRE FOR £5 WHEN YOU PURCHASE A PROJECT KIT.

The two companies mentioned below have large stocks of Easiwire solderless wire wrapping systems, as used to build all our *Simple Model Series* projects. They have agreed to make these available to EE readers who purchase complete kits of components for the projects, **INCLUDING** printed cards to cut out and assemble for each model. If you are prepared to buy *any four* of the six model kits then you can get your Easiwire **FREE**.

If you buy *any one* model kit you can purchase an Easiwire kit for just **£5**. (These kits were previously advertised by BICC-Vero at £15, including p&p). To get your kit and Easiwire simply fill in the appropriate coupon and send it with your cheque (or credit card details) to *either of the companies*.

The six projects are: Police Car (July 91); Musical Roundabout (Aug 91); Micro Micro - a dolls house microcomputer (Sept 91); Centurion Tank (Oct 91); Mini Microwave - dolls house microwave oven (Nov 91); Christmas Novelty Decoration (Dec 91). These models all play tunes or make noises or flash lights etc. They will each cost about £8 or less to build, *the prices charged will be as given by EE in the "approximate cost box."*

All prices include VAT

All the kits will be available separately as the projects are published and the £5 Easiwire offer will be available with each kit when each project is published.

Please fill in the appropriate coupon below, tick the relevent boxes and send your cheque/PO/credit card number with *one* of the coupons to:

GREENWELD ELECTRONIC COMPONENTS
27 PARK ROAD,
SOUTHAMPTON SO1 3TB
Tel: 0703 236363
Fax: 0703 236307

OR

BULL ELECTRICAL
250 PORTLAND ROAD,
HOVE, SUSSEX
BN3 5QT
Tel: 0273 203500
Fax: 0273 23077

SEND EITHER COUPON TO EITHER COMPANY - YOU CHOOSE YOUR SUPPLIER

Overseas readers please add £3 to cover the extra postage charge.

FREE EASIWIRE

Please send me my FREE Easiwire kit. I understand that I must buy four model kits at the price given by EE -

I enclose a cheque/PO for £.......... for the kits ticked below ☐

Please debit my credit card ☐

Card No. ....

Ex. Date......................Signature..

The kits I require are: Tick four *or more* boxes.

- Police Car (July '91)..............................£5.95 plus £1 p&p ☐
- Musical Roundabout (Aug '91).........£7.95 plus £1 p&p ☐
- Micro Micro (Sept '91).........................£2.50 plus £1 p&p ☐
- Centurion Tank (Oct '91)....................£4.95 plus £1 p&p ☐
- Mini Microwave (Nov '91)....................£5.50 plus £1 p&p ☐
- Christmas Novelty (Dec '91)...............£4.95 plus £1 p&p ☐

Name...

Address..

....

£5 EASIWIRE

Please supply the Novelty Kit on its own at £4.95 plus £1 p&p ☐

Please supply an Easiwire at £5 with the above kit ☐

Overseas readers please add £3 to cover the extra postage charge.

I enclose a cheque/PO for £................ (£5.95 or £10.95) ☐

Please charge my credit card - ☐

Card No. ....

Ex Date ....

Signature ....

Name ....

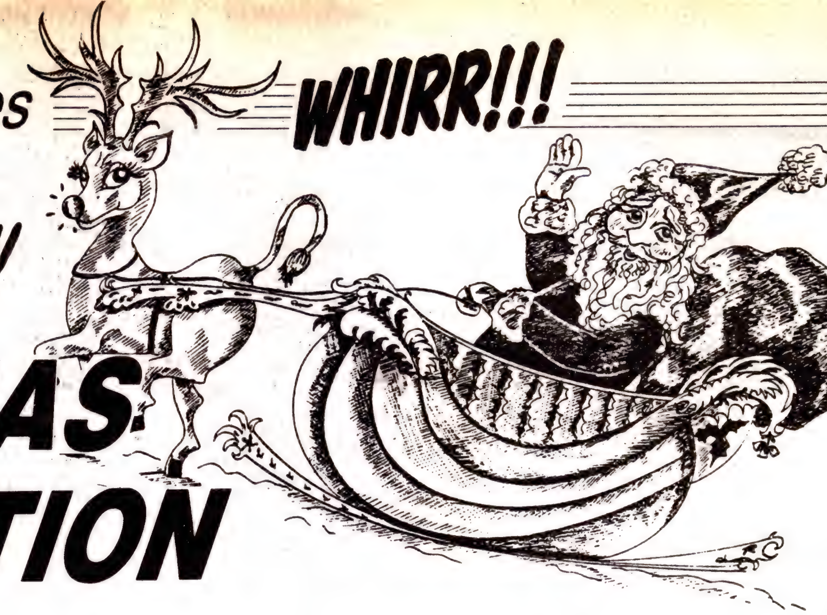
Address ....

....

....

Simple Model Series

FLASH! BLEEP!! WHIRR!!!



CHRISTMAS DECORATION

OWEN BISHOP

PROJECT 6

A novel series which combines two hobbies in one – electronics and model-making. Simple electronic circuits combined with easy-to-assemble models that cover a wide range of interests.

We continue this series of electronically enhanced models with a seasonal offering to amuse all members of the family. This decorative model can be hung on the Christmas tree, or placed on the sideboard among the Christmas cards. It is a model of Santa and his sleigh embellished with flashing lamps and a medley of Christmas tunes.

The lamps flash continuously. The medley consists of snatches of *Jingle Bells, Santa Claus is Coming to Town* and *We Wish You a Merry Christmas – and a Happy New Year.* It takes about 25 seconds to play and is repeated every one and a half minutes. Although we present the design for one particular model, the electronics can be applied equally easily to any similar model or decoration. There is also plenty of scope for ingenuity in adapting the model to suit your taste.

MEDLEY CHIP

The notes and timing for the medley are contained in a small memory included on the chip of the i.c. The i.c., which is inexpensive and is contained in a package no bigger than that of a single transistor, is one of a series intended for use in musical greetings cards.

The version specified for this project has Christmas tunes but there are three other versions available, appropriate to weddings, birthdays and Valentines. This circuit, when used with a suitable model is therefore apt for other festive occasions.

BUILDING THE MODEL

The model is in semi-relief and is built up in layers on a base-board. Cut out the baseboard from thick (2mm) card or laminations of thinner card (a). Use a steel ruler and craft knife for this operation. Also cut a sheet of matt black paper of the same size and shape as the base and glue this to the base.

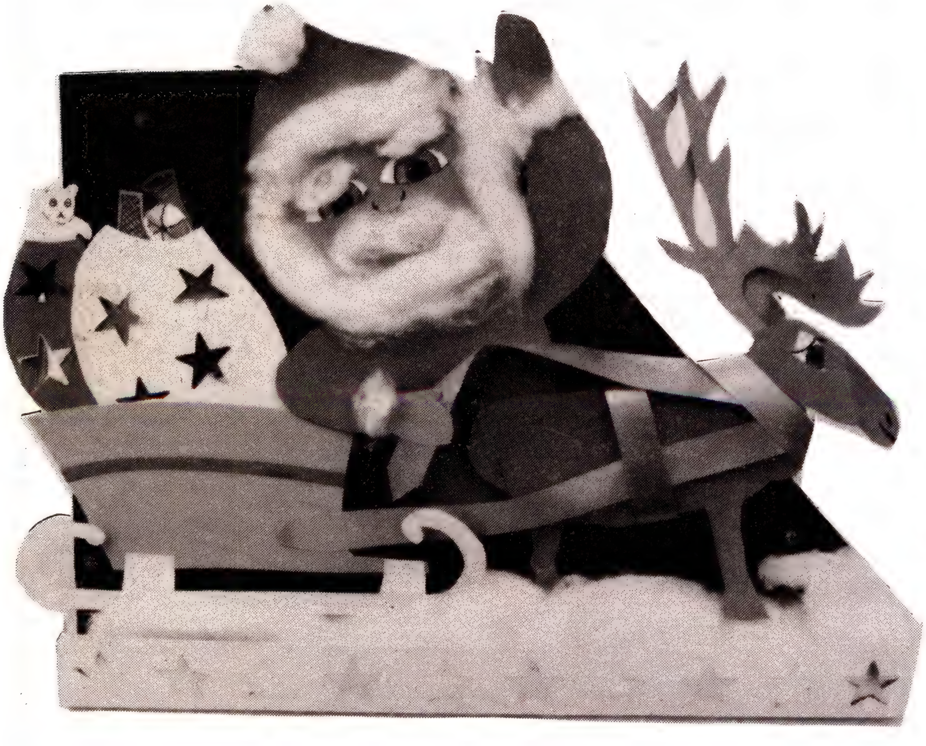
Santa is made of thin coloured card; we used bright red for his body and hat, and a light brown for his face and hands, alternatively white card can be coloured as required.

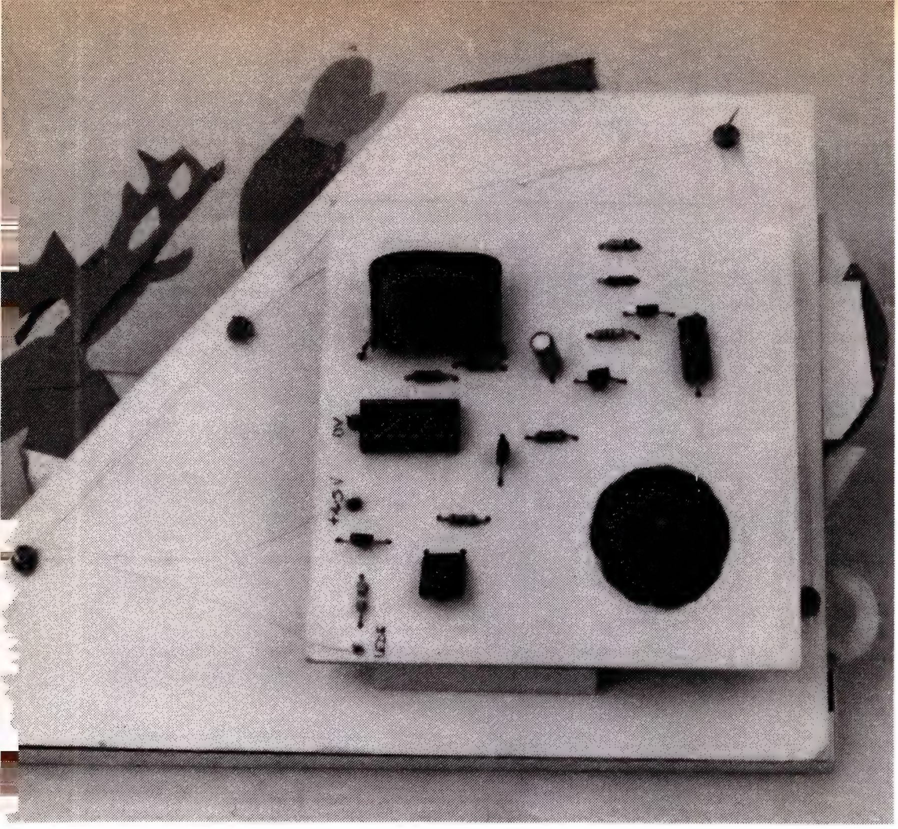
Cut out Santa's face and body and glue these to the base, on the black-papered side, leaving his right arm (left as seen from the front) free so that he can later rest it on the sleigh. Note that his left (raised) arm projects beyond the edge of the base. Cut out his hat (d), and hands (e, f) and glue these in position.

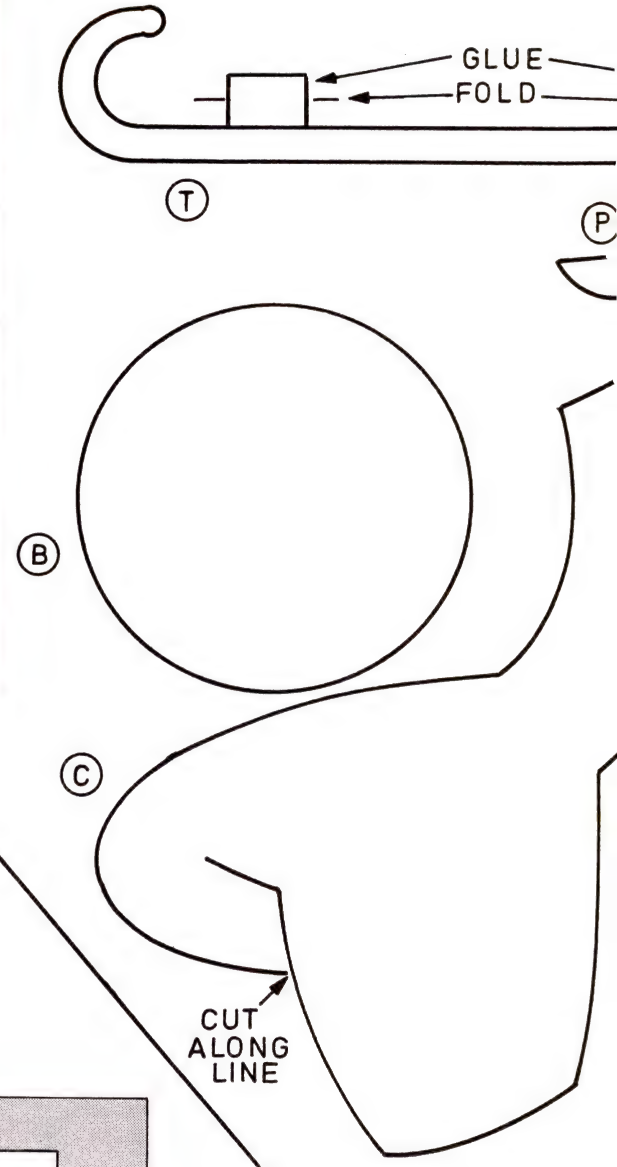
We chose a slightly darker rusty-brown card for the reindeer. Cut out the body (u) and glue the legs (h, i) to it, making sure that the bottoms of the feet are in a straight line. The body cut-out has only one antler, so cut out a second antler, with a small tab at the base for sticking behind the head. The antlers are more-or-less mirror-images of one another.

Prepare a rectangle of the thick card about 50mm x 200mm and glue this behind the body. This is for raising the reindeer away from the base to give the 3D effect. Glue the other side of the thick card rectangle and position the reindeer on the base. The bottoms of its feet are 20mm from the lower edge of the base.

The sleigh can be made in any colours that take your fancy. We have a bright green sleigh (g) with a red stripe along its side, and yellow runner (t). Cut out the sleigh body and mount it on *two* rectangles of thick card glued on top of one another. This brings the sleigh 4mm above the baseboard. As you slide the sleigh body into place, lift Santa's right arm so that his elbow rests comfortably on the upper edge of the sleigh.







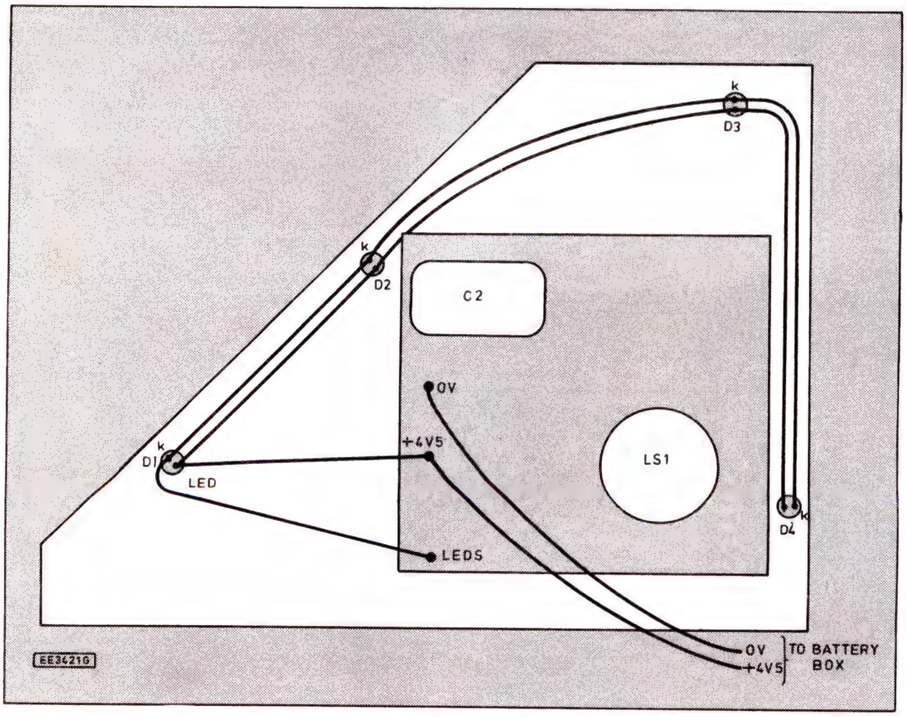
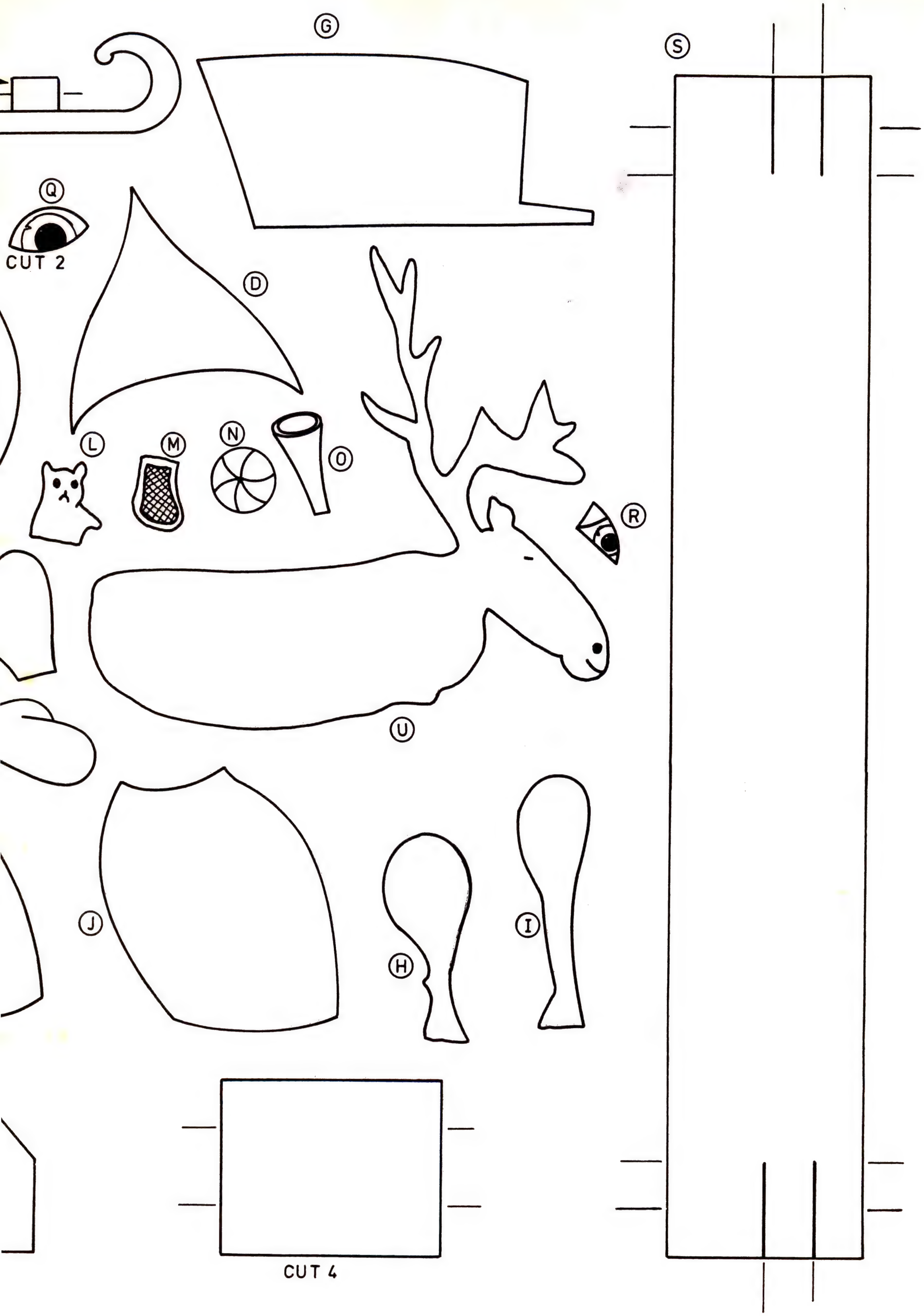


Fig. 4. Wiring the l.e.d.s and battery.

Ⓐ


G
S
Q
CUT 2
D
L
M
N
O
R
U
J
H
I
CUT 4

The runner is attached by two struts. Fold each strut back where it joins the runner (along the line), and fold up the end section at the other line. Glue the end section of each strut to the body of the sleigh. The lower edge of the runner is 20mm from and parallel to the lower edge of the base.

Cut out the sacks (j, k) from coloured card and glue these to the back surface of the sleigh; the larger sack (j) overlaps the smaller (k).

The drawings show a range of goodies to be coloured and glued behind the tops of the sacks, but you can make up your own selection. Perhaps you could draw presents that members of the family have received. Or you could cut out small photographs from the innumerable mail-order catalogues that drop through the letter-box during the pre-Christmas months.

The harness is made from gift-wrapping tape. Ours was a slightly metallised tape in a deep gold colour. Cut two short pieces and wrap them around the neck and body. Glue their ends to the back of the neck and body, leaving the tape fairly loose to give a rounded appearance. Glue a length to the inside of the neck-band, thread it under the body band and glue its other end to the sleigh. Finally, glue another length to the neck-band and let it curve in a graceful way, gluing it to the back to Santa's right hand.

The snowy terrain consists of a trough (s) made from white card, folded and glued, then glued along the lower edge of the baseboard.

Now for the final details. Glue Santa's mouth (p, in red card) in position and draw a semi-circle for his nose. Cut out and colour the eyes. Does he have blue eyes or brown? We thought that brown eyes suited our colour scheme better. The reindeer has a brown eye (r) too.

A visit to a stationer's shop will suggest innumerable ways of making the model look really festive. Ours is adorned with self-adhesive stars in various metallised colours. White cotton wool is used for Santa's beard, moustache and eyebrows, as well as for the trimming on his sleeves and the bobble on his hat. Just spread a little glue in the areas where the cotton wool is to be fixed, roll the cotton wool into shape and press it down. The trough is filled with cotton wool to just touch the runner and the feet of the reindeer.

CIRCUIT

The circuit is based on two astable multivibrators, referred to as the fast astable and slow astable respectively. An astable multivibrator is a circuit unit, the output of which alternates between high (+4.5V in this case) and low (0V) at a fixed rate. The astables comprise two inverting logic gates represented by the triangular symbols in Fig. 1. The outputs are at pin 4 and pin 12 respectively.

The rate at which the astable oscillates is determined by the value of the timing resistor and capacitor. The equation for the frequency of operation is $f = 1/2.2RC$. In the fast astable, R = 3.3M and C = 100n, so f = 1.4Hz. In the slow astable, R = 20M and C = 2µ, so f = 0.01Hz, or one oscillation in 88 seconds. The output from each astable is fed to another inverting gate, which acts as a buffer so that current can flow to the transistor switches without affecting the rate of operation of the astables.

The output of the buffer of the fast astable goes to a transistor switch TR1 which is turned on and off at the rate of 1.4Hz. When it is on, current flows through the four light emitting diodes D1 to D4. These are high-intensity l.e.d.s and take a current of about 20mA each.

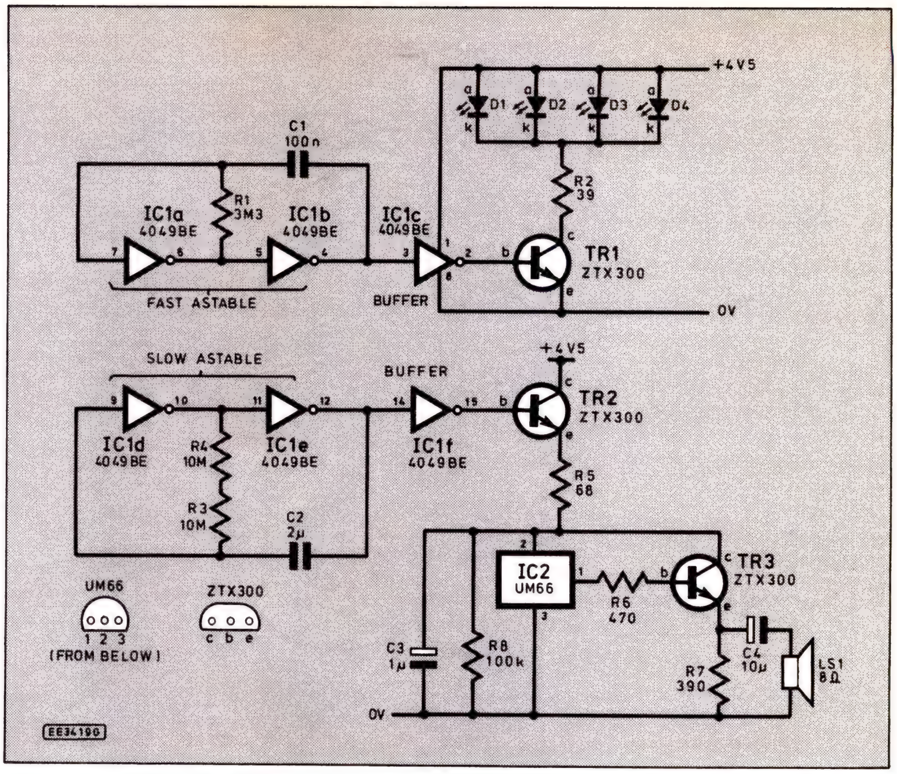


Fig. 1. Circuit diagram for the Christmas Decoration.

The output of the buffer of the slow astable goes to a second transistor switch TR2. When this is on, current flows through R5 to the music sub-circuit. R5 is a voltage-dropping resistor, since the medley i.c. (IC2) operates on a maximum voltage of 3.3V.

When TR2 goes on, a voltage appears across the sub-circuit and is held steady by C3. The medley signal comes from terminal 1 of IC2, is amplified by TR3 and drives the loudspeaker. When the tune has played once, it stops. After about 15 seconds the output from the slow astable falls and TR2 is turned off. C3 discharges rapidly through R8; discharge is essential since the fall to 0V on the sub-circuit supply resets the medley i.c. The medley repeats when TR2 is turned on again.

CIRCUIT CONSTRUCTION

The circuit is assembled on a 100mm square of thick (2mm card). Cut a circular hole for the loudspeaker, a few millimetres less in diameter than the speaker. Make holes in the board, using a sharp point or a 1mm drill. Insert the components (Fig. 2) and cut their leads to about 4mm if necessary. The large capacitor (C2) is laid on its side and held in place by a double-sided adhesive pad, or by Blutack. Its leads are bent sideways and inserted in the holes. Glue the rim of the loudspeaker to the *wiring* side of the board.

Wire up the board circuit as in Fig. 2. Check that the wiring to the loudspeaker does not touch against its rim. Small rectangles of p.v.c. insulating tape are placed where shown to prevent short-circuits between crossing wires.

When complete except for the l.e.d.s, check the following points; IC1 is in its socket the right way round, the transistors and IC2 are properly orientated, C3 and C4

COMPONENTS

See SHOP TALK Page

Resistors

R1	3M3
R2	39
R3, R4	10M (2 off)
R5	68
R6	470
R7	390
R8	100k

All carbon, 0.25W, 5%

Capacitors

C1	100n polyester
C2	2µ polyester
C3	1µ elect. 15V
C4	10µ elect. 15V

Semiconductors

D1 to D4	high intensity light emitting diode (4 off)
TR1 to TR3	ZTX300 *npn* transistor (3 off)
IC1	4049BE CMOS hex inverting buffer
IC2	UM66 Type 1 medley generator

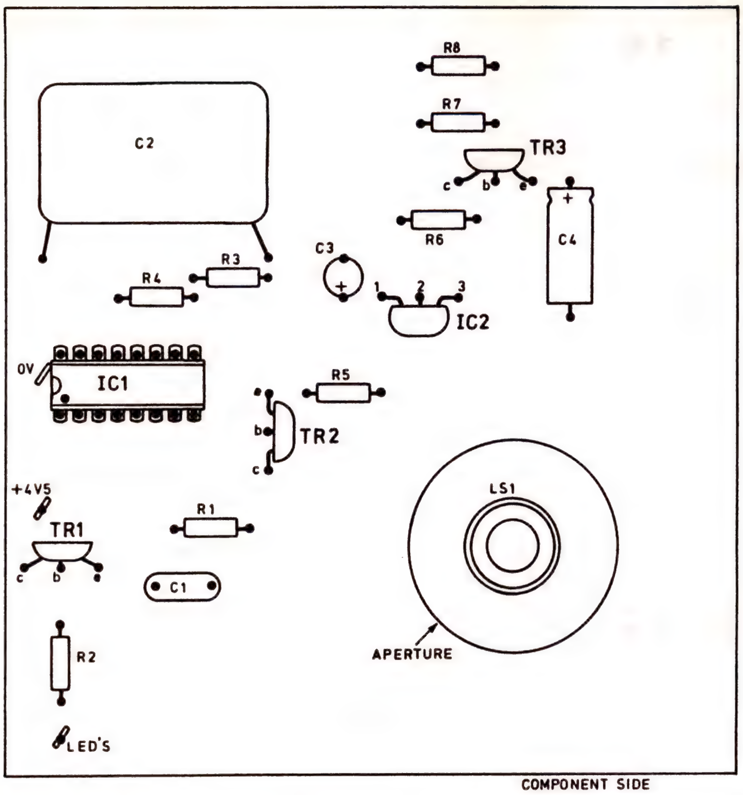
Miscellaneous

LS1 8 ohm miniature (38mm diam) loudspeaker; 16-way d.i.l. socket; p.c.b. eyelet terminals (3 off); 3-cell battery-box and suitable cells – see text.

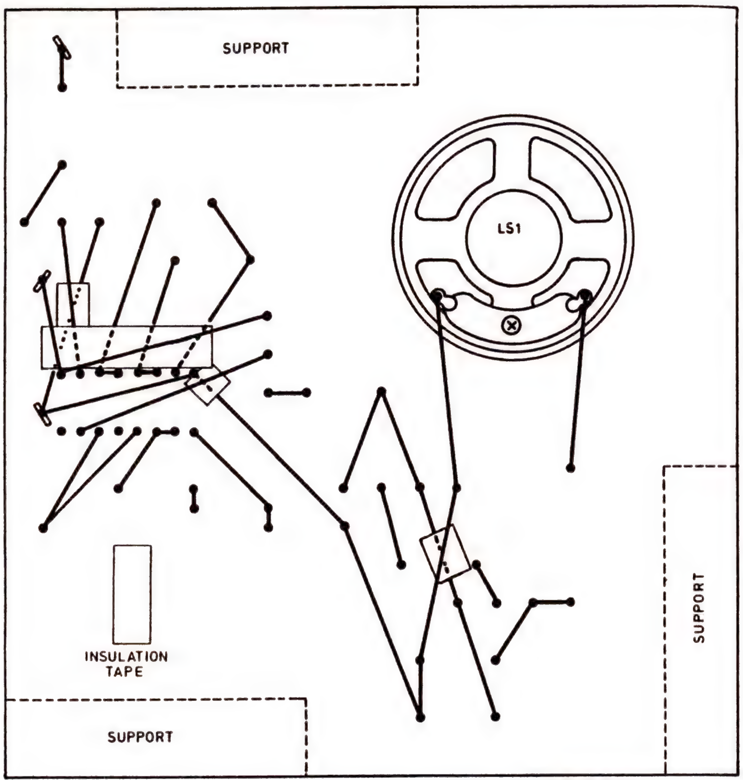
Materials required

Thin coloured card (250g/m²), red, green and other colours; medium white card (1mm, 650g/m²) for the terrain and board supports; thick white card (2mm, 1500g/m²) 100mm square and 200mm x 150mm, alternatively painted white printed card as supplied (see Shop Talk and Special Offer pages); Tinsel; coloured self-adhesive stars etc., for decoration; cotton wool (white); clear adhesive.

Approx cost guidance only **£5**



COMPONENT SIDE



WIRING SIDE

Fig. 2. Circuit card layout and wiring.

are connected with correct polarity, there are no connecting wires touching (particularly in the vicinity of IC1), unwrapped "tails" at the ends of wires are not contacting adjacent wires or pins.

Test the circuit by applying battery power. The circuit operates on 4.5V (three 1.5 cells in a battery box). Operating it on a higher voltage is likely to destroy the medley-making i.c. The tune may start as soon as the power is applied, or there may be a delay of about 30 seconds, depending on the state of the slow astable to begin with.

The voltage level at pin 2 of IC1 alternates between 0V and 4.5V about twice a second; this is the output of the fast astable. If you have a breadboard or a supply of test leads with crocodile clips, temporarily connect the l.e.d.s (in parallel) between the +4.5V terminal and the l.e.d. terminal. The l.e.d.s flash brightly about twice a second. If the circuit is not working, remove the battery, check the wiring and other points again. If the l.e.d.s fail to flash, it may be because they are connected with the wrong polarity. Normally the cathode wire (which connects to the l.e.d. terminal) is identified by a "flat" on the rim of the l.e.d., but we found that the special high-intensity l.e.d.s used in the prototype had the "flat" by the anode wire.

SLOWER

If you feel that it would be better to have the tunes played less frequently, you can make the slow astable run even more slowly by increasing the capacitance of C2. This is best done by using a 4µ7 capacitor or by wiring a second (or even a third) 2µ capacitor in parallel with C2. A second capacitor halves the rate at which the medley is repeated.

The extra capacitors could be stacked on C2, and held in place by adhesive pads. It is essential to use polyester capacitors or another low leakage type. Although electrolytic capacitors have high capacitance and might be thought suitable for the low astable, they have relatively high leakage. The current flowing through the 20M combined resistance of R3 and R4 would mostly leak away through the capacitor, which would thus fail to charge.

When the circuit is working properly, lay it on a sheet of newspaper, wiring side up, cover the loudspeaker with a scrap of paper and spray the board with p.c.b. lacquer. This step is not essential but it serves to hold the wrapped wire more securely in position, especially the wires around the pins of the i.c. socket.

FINAL WIRING

Make three supports from medium-thickness card. Bend these twice. Glue one flap of each support to the wiring side of the circuit board. Glue the opposite end of each support to the rear of the base-board (Fig. 4). Bore holes in the base-board just wide enough to allow the l.e.d.s to be inserted from the rear. A drop of glue holds each l.e.d. in place. Cut their leads to about 5mm long.

Run a wire from the +4.5V terminal to the cathodes of the l.e.d.s. Run a wire from the l.e.d. terminal to the anodes. These are rather long runs, so keep the wires as tight as possible, so that they do not come into contact with each other. Use pieces of insulating tape to separate the wires, if necessary.

BATTERY

The average current consumption is about 40mA, and the model is likely to be run for several hours at a time during Christmas, so it is preferable to use size C or D cells in the battery. A battery box holding three cells in a row can be wrapped in Christmas paper and disguised as a Christmas cracker or as a wrapped gift. Alternatively obtain the supply from a 4.5V d.c. mains adaptor.

READY FOR ACTION

We have not provided a switch, since it is usually more convenient simply to twist one of the power leads around the power terminal when the novelty is to be set working. If it is to be hung on the Christmas tree or among other decorations, attach a loop of tinsel or coloured cord to the upper edge of the base. The battery, suitably disguised as described above, is hung from an adjacent branch. Alternatively, make a cardboard support so that it can be rested upright on a horizontal surface.

The antlers may have flattened by now so spread them out sideways. The upper parts diverge slightly from each other, but the lower, forwardly-directed branches are spread wide apart to give the beast a fierce (!) appearance head-on. □

Special Series

MAGNETIC RECORDING

Part 3: Head Maintenance

VIVIAN CAPEL

Life today would be difficult to imagine without magnetic recording: No audio or video recorders; no computer disks; no payphone cards; no bank cash cards or magnetic security pass cards. In spite of its universal use, magnetic recording and the principles of magnetism are still little understood by most people. In this short series we hope to answer some of the questions most often asked about Magnetic Recording.

THE MAJORITY of problems that occur with audio tape recorders are due to head faults and mechanical failures. Of these, the heads are the most common culprits, which is not surprising considering that in a cassette recorder, 562.5ft (168m) of moving tape is pressed against them every hour of recording or playback.

The principal cause of trouble is loose oxide particles from the tape. While with modern good quality tapes only a very small number of particles in proportion to the total becomes free from the binder, with thousands of feet of tape passing, the number soon builds up.

These are deposited on the head face and attract others. In time a blob of significant size accumulates which is compacted by tape pressure to form a hard mound that adheres strongly to the face.

TENTING EFFECT

What then happens depends upon what part of the head-face it happens to be. Often the particles are pushed by the tape to the furthest point of contact. Being well past the gap, the deposit may not have any great effect. But if it is near the gap, the tape rides over it and produces a ***"tenting"*** effect whereby the mound holds the tape off from the head-surfaces on either side of it (Fig. 1).

The loss of intimate tape/head contact across the gap affects recording differently from playback. With recording, the flux must pass through the space formed by the "tent" before it reaches the tape. Thus less flux actually penetrates the tape coating, so the recorded level is lower and noise is increased.

It is even worse if the deposit is across the gap itself. Then, in addition to holding the tape off, it also forms a magnetic short-circuit which bypasses a lot of flux. This further reduces the flux reaching the tape and decreases recording level.

The tenting effect is more serious with playback than with recording. The physical size of the field eminating sideways from a bar magnet is dependant on its length. It extends only half the distance compared to another magnet that is four times as long. Now the length of the recorded zones on the tape depends on the recorded wavelength, which in turn depends on the frequency. High frequencies have short wavelengths and therefore short magnetic recorded zones.

This means that the field from a recorded high frequency extends outward from the tape only half the distance compared to that from a frequency that is two octaves below. Tenting effect thereby reduces the fields picked up by the gap from high frequencies, to a greater extent than those received from low frequencies. So, tapes played with a dirty playback head lose more treble than bass and thereby sound muffled and lacking in top.

The fact that dirt on the head has a more serious effect on playback than recording is really an advantage. It has happened that a tape has been recorded, but sounded awful when played back. Examination of the record/playback head revealed it to be dirty.

As the recording was made with the head in this dirty condition, it seemed logical that the recording was ruined and was useless. But this has not always been so. On cleaning up the head and replaying the tape, it has often been found that though not perfect, the recording is quite acceptable.

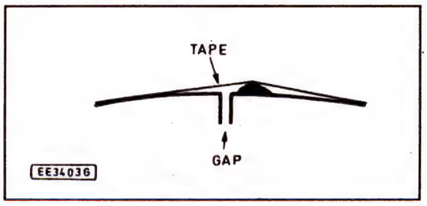


Fig. 1. 'Tenting' effect. A blob of dirt holds the tape off from the gap producing low-level recordings, and loss of field from short magnetic zones (high frequencies) during playback.

Another possible effect from dirt is tape ***flutter***. Deposits tend to be sticky and thereby impede the smooth passage of the tape over the head. It passes in a series of minute snatches and jerks as the deposit alternately holds and releases the tape. Sometimes an audible squeak can be heard from the head with the volume turned right down.

The reproduced effect is distortion. If it was present during a recording, it is permanently recorded and nothing can be done to save it. If though it is heard when playing a tape that was previously free from it, there is no permanent damage and cleaning the head should restore things to normal.

HEAD CLEANING

The obvious solution to all these problems is to keep the heads clean, yet it is a chore that is often neglected, and many recorder owners seem unaware of the need of doing so. I once worked in the service department of a well-known tape-recorder manufacturer and was surprised how often machines were returned for repair with nothing wrong with them other than dirty heads.

An easy way to clean heads is to use a head-cleaning cassette which usually contains a length of woven fabric "tape". When this is "played" it removes oxide deposits by friction. The suggested frequency of use is once every 25 hours, but this is not critical enough to warrant keeping an accurate log of playing time.

Unlike a worn gramophone stylus a dirty head will not damage the tape. Overuse could accelerate head wear, so there is something to be said for using it only when the sound begins to deteriorate.

The best method is hand cleaning, which is easier if full access to the heads is obtained by removing the cassette flap. The flap is usually retained in the open position by side pieces that have small side projections which engage against the inside of the case.

Removal can be effected by gently pressing the side pieces inward until the projections disengage, whereupon the flap can be lifted off of its pivot. A spring may also need to be disengaged from its retaining hole. The flap is re-fitted by reversing the process. After the first time, further flap removals and head cleanings are that much easier.

With the flap out of the way, the state of the heads can be observed; a magnifying glass is useful for this. If they are still not very accessible, press the play button to bring them down into the playing compartment. *It is important to ensure that the power lead is disconnected and the* *batteries removed when carrying out this operation.*

Cleaning can now be carried out by using a cotton bud and head cleaning solution. A cheaper alternative to proprietary cleaners is industrial alcohol or methylated spirit. Wet the head face thoroughly and remove all visible deposits, using a magnifying glass to make certain that the smallest deposit has been eliminated.

It is important that after doing so, and *before* the head is dry, the face is polished with a dry bud (the other end of a dual-ended one). If this is not done a sticky film may remain. As the cleaner evaporates quickly, polishing must be started as soon as the dirt has been removed.

Take a look at the rubber pincher roller, drive capstan, and tape guides. Deposits can also collect on these, producing speed irregularities and the effect known as ***wow***. Clean as required.

Hand cleaning with buds is gentle and can be done as often as needed without causing head wear. It is also more thorough than cleaning tapes as they can and often do leave stubborn deposits untouched.

WEAR

A flat channel, the width of the tape, is sometimes worn across the head face and gradually gets deeper as wear continues, see Fig. 2. With a permalloy head, the most common and softest head material, the beginnings of a channel becomes evident quite soon after the head is new, but it takes much longer to appear with ferrite or HPF.

Of itself, the wear has little effect until the channel is really deep, providing that it is even. It is when it is uneven that problems arise. A dimple can appear near the gap which prevents intimate tape contact, thereby causing high frequency loss. The edges of the laminations can become rounded or jagged so increasing the effective gap width thereby reducing playback high frequency response.

Part of the shim can break off leaving a cavity in the gap. At best this allows part of the flux to bridge the gap internally instead of externally through the tape, but in addition, oxide deposits can collect in the crevice so providing a low-reluctance path that further reduces the flux through the tape.

Crevices or uneven edges tend to quickly collect debris from the tape, necessitating frequent cleaning of the head. So if a head often needs cleaning it is usually a sign that it is badly worn and it is time to replace it.

Before doing so though, examine it under magnification and if there seems no serious unevenness of wear try a different make of tape. Sometimes a faulty batch of tape comes on the market that sheds oxide readily, though this is rare with the reputable makes.

Cases have been known where the sides of a worn channel grips the edges of the tape causing it to bind or curl. Yet otherwise the wear is even and has no effect on reproduction. In such cases, the edge of the channel furthest from the gaps can be smoothed over by the careful application of a very fine wet-and-dry emery paper, (Fig. 2).

Normally one should *never* introduce an abrasive to the heads, but as the head must otherwise be replaced, nothing is lost by trying to improve matters. Use the paper wet and concentrate the gentle rubbing action against the lower ridge, avoiding the face as much as possible.

This is best done by cutting a strip of wet-and-dry about one-eighth inch wide (3mm) and drawing it sideways back and forth along the edge of the ridge. Leave the other ridge adjacent to the gap strictly alone, it only needs one to be levelled to stop binding; abrading the other will be sure to damage the gaps.

MAGNETIZATION

In time, the head can acquire a degree of permanent magnetization. The effect is to add noise to recordings. ***Demagnetization*** should be carried out periodically and can be accomplished without the need to remove the cassette flap. A demagnetizer consists of a coil in a plastic handle with a probe running through its centre and extended from the end so that it can be introduced to the head. Some are cranked at the end to facilitate easy application to the head.

The coil is plugged into the domestic mains supply, and the probe placed against the head. A plastic cap prevents it scratching the face. The probe is then gradually pulled away from the head face, which is thereby demagnetized.

What happens is that the head material goes through successive but diminishing *hysteresis* cycles as the probe is drawn away, until finally it is left with zero magnetization. The recorder MUST be switched off for this operation otherwise a very loud hum will result which could damage the speakers.

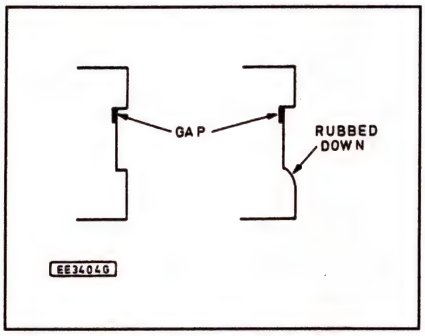


Fig. 2. A channel may be worn in the head that grips the tape, producing speed irregularities (a). The effect can be eliminated by carefully rubbing down the ridge furthest from the head gaps with fine wet-and-dry emery paper.

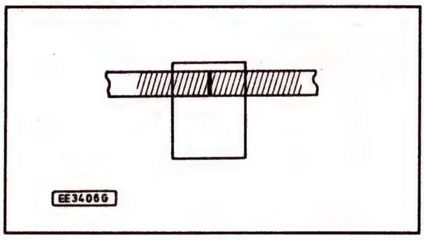


Fig. 4. A tape recorded with an incorrect azimuth head has slanting magnetic zones and so results in high frequency loss when played with a head that is correct. There is no loss when played with the same head that recorded it.

Some head-cleaning cassettes also demagnetize the heads by means of internal revolving magnets. The effect is rather less positive than the mains operated demagnetizer.

AZIMUTH

Azimuth describes the sideways tilt of a record or playback head. The head gap is a vertical slit which records magnetic zones consisting of a series of vertical stripes, wide ones for low frequencies and narrow ones for high. Imagine a playback head slightly tilted to one side so that the gap is not vertical. The gap now forms a diagonal across two or more adjacent narrow recorded stripes although it may not span more than a single wide one.

The resolution is thereby reduced; the effective width of the gap is increased to that of its vertical projection (Fig. 3). Thus the reproduction of recorded high frequencies is impaired, although that of low frequencies is unaffected.

Let us now consider the situation when the *recording* head gap is tilted. The resulting recorded magnetic zones are not vertical but tilted the same way as the gap. If these are played by a vertical playback head, its gap thereby forms a diagonal across them just as in the previous case, (Fig. 4). So the result is the same, loss of high frequencies when reproduced.

If though the tape with tilted zones is played on the *same* single-headed machine that recorded it, the head gap is aligned to the angle of the zones and there is no h.f. loss. This is why tapes recorded on a machine with a mis-adjusted head sound perfectly normal on the same recorder, but fuzzy on any other, while tapes recorded on other machines sound poor when played on the first machine. This effect often perplexes recorder owners!

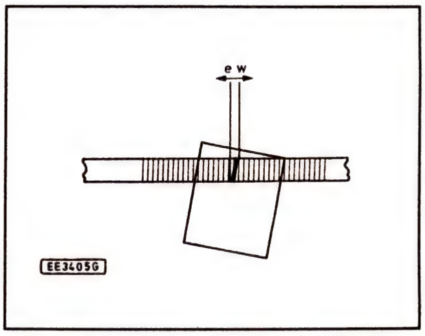


Fig. 3. Incorrect azimuth. The gap of the tilted head spans more than one vertical recorded zone thereby increasing its effective width (e.w.), so reducing resolution and losing high frequencies.

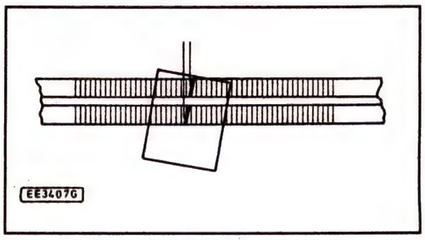


Fig. 5. Playback with a stereo head of incorrect azimuth not only suffers loss of h.f., but has one channel lagging in time behind the other, so producing phase errors between channels and thereby impaired stereo.

IMPAIRED STEREO

There is another effect of mis-aligned heads, and that is impaired stereo. Taking a look at the exaggerated mis-aligned stereo head in Fig. 5, it is evident that one gap is displaced laterally from the other along the tape, whereas they should be exactly vertical. So, one gap will be ahead of the other in reading its track. Phase

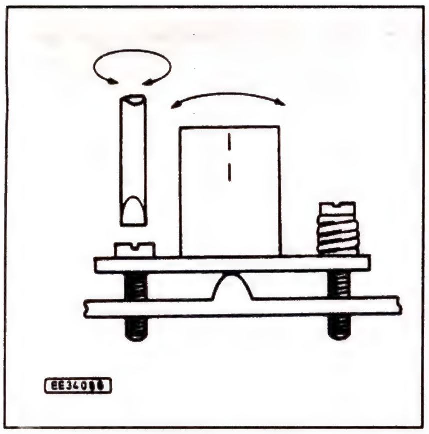


Fig. 6. Azimuth is adjusted by rocking the head over a central pivot against the tension of a spring.

differences, which are really differences, that were present in the original recording will thus be altered, and spurious ones introduced.

As stereo location is conveyed principally by the phase relationship between the two channels, it is evident that a mis-aligned head will give poor and inaccurate stereo. However, a stereo recording made and played back on the same single-head machine will not be impaired because it will be played back as it was recorded.

AZIMUTH ADJUSTMENT

With some machines the record/playback head is bolted rigidly to the sub-chassis and so no adjustment is possible. With others the base of the head is mounted across a ridge running from the back so that it can rock from side to side. There is a flange on each side of the head, each having a screw securing it to the sub-chassis. One of these has a spring under its head which holds the flange in place when the other screw is adjusted (Fig. 6).

The audio engineer adjusts the azimuth by using an audio oscillator and an output meter. A 10kHz signal is recorded on a cassette using a recorder known to have a correct azimuth, or a pre-recorded test tape. The tape is then played on the machine to be adjusted and the head screw rotated to obtain a maximum reading on the output meter.

For a stereo recorder the output of one stereo channel is fed to the *Y* and the other to the *X* plates of an oscilloscope. A ***lessajou*** figure is obtained that indicates phase difference, (Fig. 7). Azimuth is adjusted for minimum phase difference.

If you have no test equipment, do not despair, an accurate adjustment can still be made if you have a good ear. Record some f.m. interstation noise on a radio cassette recorder that is known to be correctly adjusted. This is known as "*white*" noise.

Play the "noise" tape on the machine to be set up and listen carefully. Set the head for maximum "hissiness", turning the screw to both sides of maximum with decreasing adjustments until it is spot on the maximum setting. Machines carefully adjusted in this way have later been checked with instruments and found to be at optimum, and that no further improvement could be made.

Remember that if the azimuth is incorrect, there will be no impairment of the sound of tapes recorded and played back on the same instrument, but it will be incompatible with all other machines and with pre-recorded tapes.

HEIGHT AND TILT

The height of the head must be such that the tape path past *all* heads and guides is a perfectly straight line. If this is not so the tape will curl and distort, or in the case of a cassette recorder in which the heads move in to engage with the tape, one of the head-guide arms will foul the tape causing a series of creases along one edge (Fig. 8).

Usually, the head height is not adjustable and the guides are fixed to the side of the head, so no height setting is required, but in some models it is adjustable. It is not unknown for a head guide to become loose and mis-positioned, especially on an erase head which, having a plastic encapsulation, does not have its guide welded on as does the metal-cased record/playback head. The result, can be tape damage as described. There may also be fore and aft tilt adjustment but this is normally only found on open-reel machines.

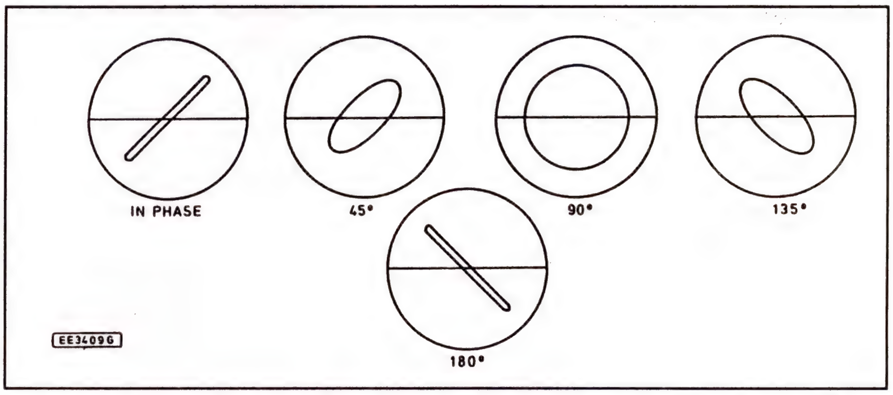


Fig. 7. Phase differences revealed by scope traces. The two stereo channels carrying a recorded fixed h.f. tone, are fed into the X and Y scope inputs. The azimuth is adjusted for the 'in phase' trace.

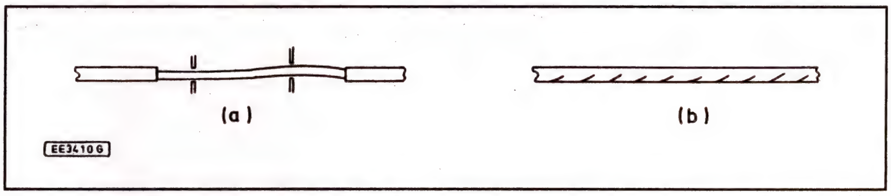


Fig. 8. A tape guide out of line (a), can produce creasing of one edge (b).

ERASING

An essential part of any tape recorder is the ***erase*** system. It is this that gives the medium its remarkable versatility; tapes can be re-recorded over and over again with no deterioration. Any wear is due to the friction of the tape passing over the heads not by re-recording. An equal amount of wear will result from the same number of playings of the initial recording.

The erase head clears all previous recordings by brute force. In the case of ***d.c. bias*** it also plays an important part in the actual recording process as described more fully in a previous article. Briefly, the tape is magnetically saturated by the erase head. The bias applied by the record head is of opposite polarity from this so that the operation is brought down to the long straight demagnetization portion of the *hysteresis loop*.

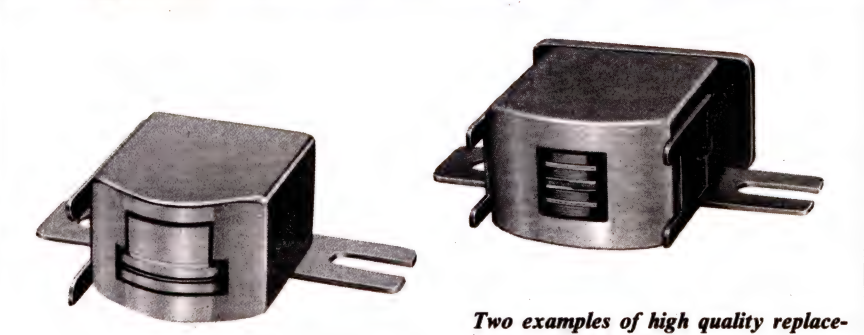
Sometimes d.c. erasure is used with ***a.c. bias***. In this case, the tape saturation plays no significant part in the recording and serves only to wipe out previous recordings.

D.C. erasure can be accomplished either by a permanent magnet or a d.c. current passed through the windings of an erase head which is similar in construction to the record head. When a magnet is used it cannot of course be switched off so it must be physically retracted from the tape path during playback.

For ***a.c. erasure***, the full output of the bias oscillator is applied to the erase head. Unlike the bias therefore, its exact value does not need to be pre-set. It is usually about a hundred times the bias current.

The erase-head gap is large, typically 200μm, and thereby penetrates right through the tape coating to leave no trace of signal buried beneath the surface. It also covers almost half the width of the tape, thereby erasing a mono or pair of stereo tracks from tape edge almost to the centre. A narrow centre area is left to avoid erasing any part of the inner track on the other half.

Next month: Head Driver Circuits.



Two examples of high quality replacement cassette heads.
(Courtesy of Hart Electronic Kits.)

SMALL IS BEAUTIFUL

STUDIO POWER **SUB 2002** SUB WOOFER

STEREO SYSTEM

The new Studio Power Sub 2002 Sub-Woofer Stereo Loudspeaker System is now available, and offers an outstanding sound package at an affordable price.

Due to modern technology, gone are the days when rooms are cluttered with bulky, intrusive speakers. To reproduce the rich bass notes, Studio Power have developed a single sub woofer incorporating twin 61/2 inch drivers (in push/pull). Bass signals contain little directional (stereo) information. So, this unit can effectively be 'hidden' anywhere in the room, such as behind the sofa, curtains, or under a coffee table - yet still deliver the whole weight of the lower audio spectrum.

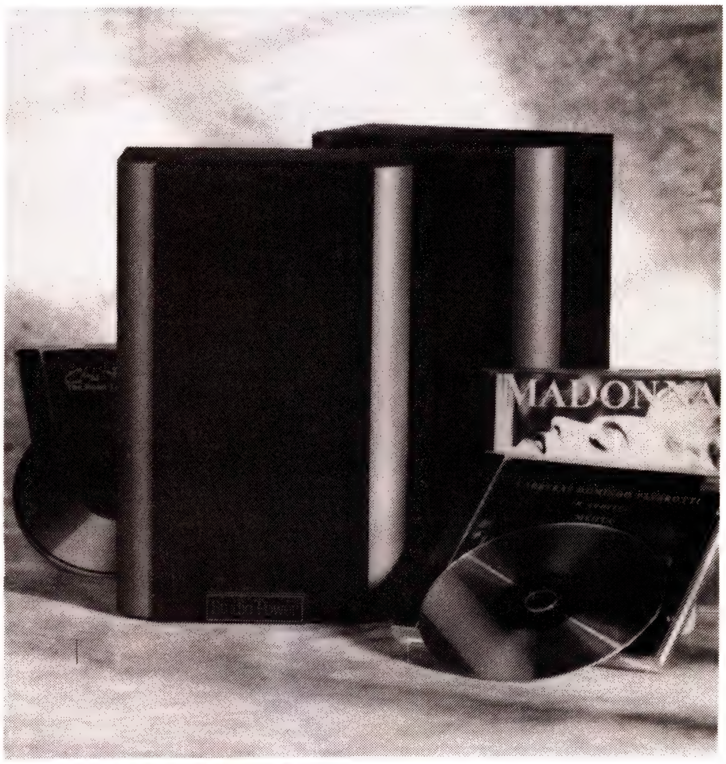
The 'mid' and 'upper' frequency regions are handled by a pair of Studio Power's innovative satellite speakers, each incorporating a 4 inch mid-range and a 1 inch tweeter. Because of the low frequency cross over point between the sub-bass woofer and the satellite units, your ears will detect the deep bass, purporting to come direct from the small satellite units, giving a wonderfully impressive overall performance.

All three units are finished in a deep grey, smooth finish, with the satellites having a contrasting black fabric grille. If you are looking to purchase any small pair of traditional loudspeakers, up to £130.00 per pair, or any other Sub-Woofer system, costing considerably more, we suggest that you purchase the Sub 2002 System. Why pay more? At £129.00, everyone can afford the luxury of a true sub-woofer system.

The new Studio Power Sub 2002 Sub Woofer System offers quality stereo sound from two small satellite loudspeakers, with additional rich bass from a single discreet omni-directional sub-woofer. This is ideal for integration into your Hi-Fi or audio-visual system. All this for just £129.00 complete plus £6.00 carriage.

TWO SATELLITE SPEAKERS • BASE BIN •

£129
COMPLETE
Plus £6.00
Carriage



Technical Specifications:
POWER HANDLING
RMS - 60 Watts
Music Power - 100 Watts
Suitable for Amplifiers rated 10-60 Watts R.M.S. per channel
Impedance - 8 OHMS
Satellite Tweeter - 1 Inch
Satellite Mid-Range - 4 Inch
Bass Bin - 2X6.5 Inches
Frequency Response - 45-20.000 Hz
Dimensions - Satellite 225 X144 X 90 cm
- Bass Bin 460 X 310 X 200 cm

To order, please send cheque or postal orders, payable to B.K.Electronics, for £129.00 plus £6.00 carriage. Orders can also be placed by post, telephone or fax using either Access or Visa cards.
Please send your order and payment to:

B.K. Electronics, Units 1/5 Comet Way, Southend-onSea, Essex. SS2 6TR.
Telephone: 0702-527572. Fax: 0702-420243.

Constructional Project

AUTO NIGHTLIGHT

A. R. WINSTANLEY

A simple-to-build unit which operates and automatically dims a low voltage nightlight for the nursery.

DURING the early years of infancy it is often comforting to a child to be able to sleep in surroundings which are illuminated by a gentle nightlight, in order to allay any fear of the dark that the child may have. Hopefully, it is not necessary to keep the room's main light switched on, and with luck a small lamp such as a pygmy-type will have the necessary calming effect.

Often a "plug light" is used, which comprises several neon bulbs encased in a translucent plug top. These form a cheap solution, but they can obviously only be placed where the mains socket is located. An alternative is the traditional candle nightlight, but there are obvious drawbacks relating to safety and peace of mind.

The Auto Nightlight is a simple mains-powered low-level lamp but which has the added attraction of automatically dimming itself over an hour or so, if required; the design is obviously an improvement over a simple plug-type nightlight, since you can firstly select either "auto-dim" mode or "bypass' where the lamp will be continuously alight. Secondly, the lamp itself can be placed exactly where you require it – next to the cot, for instance – since the lamp operates at 12V and there are no potentially hazardous mains cables trailing everywhere.

CIRCUIT DESCRIPTION

The circuit itself is extremely straightforward and is ideal for the less experienced constructor wishing to tackle a simple mains-powered project for the first time. The circuit diagram of the Auto Nightlight is shown in Fig. 1.

Mains voltage is switched through S1, the On/Off control, and passes via a protective fuse FS1 to the primary windings of transformer T1, where it is stepped down to 9V a.c. This lower voltage is full-wave rectified by the bridge rectifier D1-D4 to produce a direct current. Capacitor C1 is a relatively large smoothing capacitor which smoothes out the ripple content of the bridge rectifier output, the net result being a d.c. voltage of approximately 15V-16V no load, 11V-12V on load.

A single pole changeover switch S2, which is a centre-off type, is biased one way. When the switch is moved to the "DIM" position, capacitor C2 charges up from the 12V supply rail; when the switch is released, it returns to the centre-off position but the charge on C2 is retained. Positioning S2 in the other direction would connect C2 continuously to the positive rail.

The Darlington transistor TR1 can be considered as two transistors in one package, as depicted by its schematic symbol. It is a very high gain transistor, a figure of 20,000 being typical. This implies that compared with a normal bi-poplar transistor, TR1 requires only a very tiny base current to saturate the transistor hard on. The Darlington in fact acts as a driver transistor for TR2, with a higher permissible collector current rating than the Darlington itself; hence, TR2 can drive a larger load than could TR1.

Once capacitor C2 is fully charged in the "DIM" mode, both transistors turn on like a switch. TR1 requires its base (b) to be 1.2V more positive than its emitter (e) because it contains two transistor junctions, whilst TR2 base must be just 0.6V more positive for that transistor to conduct.

Since the voltage at C2/R2 junction is about 12V due to the charge stored on capacitor C2, both transistors switch hard on or "saturate". This completes the circuit to lamp LP1, a 12V 2.2W bulb connected via jack socket SK1, and LP1 will therefore illuminate.

Capacitor C2 will discharge very slowly through resistor R2 via the base terminals of TR1 and TR2 to 0V. However, provided that the potential at TR1 base remains at 1.8V or more, both transistors will remain on, and hence the bulb will remain alight. Once the voltage drops to below this figure, the transistors will start to turn off, with the effect that LP1 will be seen to dim very slowly until it has extinguished altogether.

Unfortunately, it is very difficult to predict precisely the time period that will elapse before LP1 extinguishes. This is because of the very large manufacturing tolerance on capacitor C2, typically its value is 330μF −50% +100%.

The prototype Auto Nightlight started to dim after about 50 minutes or so. This was considered adequate for this application. The fact that the lamp stays fully alight for quite some time before starting to dim was also considered beneficial.

As mentioned earlier, if switch S2 is moved to the "ON" position, then the base of TR1 is connected via resistor R2 directly to the positive supply rail. In this case the dimming function is bypassed and the lamp will remain fully alight. Under these circumstances it is necessary to turn off at the mains in order to extinguish the lamp, due to the charge that is stored on C2.

CONSTRUCTION

Most of the components, including the mains transformer, are mounted onto a printed circuit board (p.c.b.), see Fig. 2. This is available from the *EE PCB Service*,

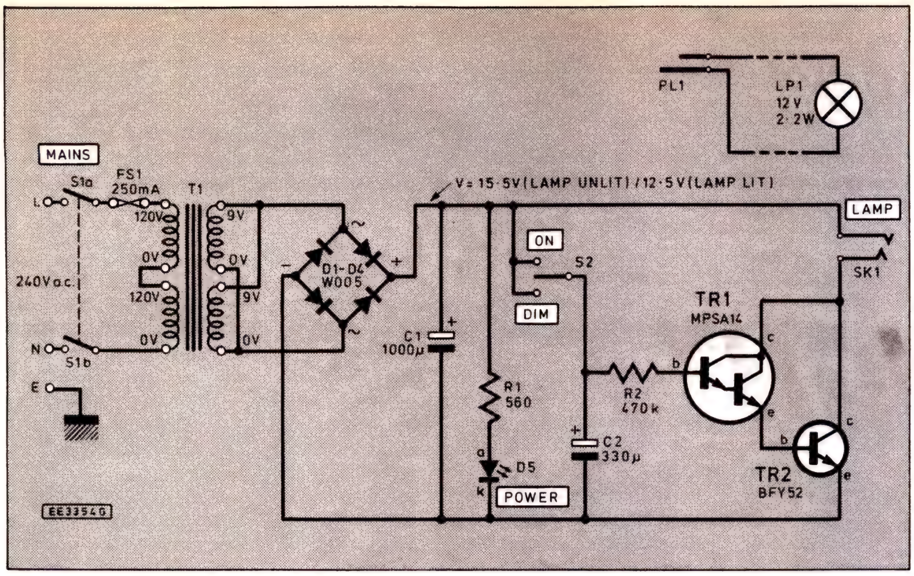


Fig. 1. Complete circuit diagram of the Auto Nightlight.

COMPONENTS

See **SHOP TALK** Page

Resistors

R1	560
R2	470k

Capacitors

C1	1000µ axial elect. 25V
C2	330µ axial elect. 25V

Semiconductors

D1-D4	W005 50V 1.5A bridge rect.
D5	red l.e.d.
TR1	MPSA14 *npn* Darlington
TR2	BFY52 *npn* gen. purpose

Switches

S1	D.P.S.T. mains rated toggle
S2	S.P.C.O. centre-off toggle, biassed one way to match S1

Miscellaneous

T1	6VA mains transformer p.c.b. mounting; 240V primary, 9V 6VA secondary
SK1	3.5mm mono jack socket
PL1	3.5mm mono jack plug
FS1	250mA 20mm p.c.b. mounted fuseholder
LP1	12V 2.2W MES bulb in batten holder (see text)

Plastic case, size 155mm x 85mm x 60mm, with aluminium front and rear panel (Vero 75-1238D); single-core screened cable (or "figure-eight" twin-core flex), length to suit; 6A 3-core mains cable; mains rated 2-way p.c.b. screw terminal block; TO5 push-on heatsink; materials for lamp diffuser; connecting wire; solder etc.

Printed circuit board available from EE PCB Service, code EE779.

Approx cost guidance only **£14.50** *plus case*

code EE779, or can be home-made in the usual manner. Only an *experienced* constructor should attempt to translate this circuit onto stripboard instead of using a p.c.b., because the board contains a mixture of mains-operated and low voltage parts.

The p.c.b. was designed, by virtue of its fixing centres, to fit into a Verobox No. 75-1238D measuring 155mm x 85mm x 60mm but any other similar case would suffice. The approved box has a top and bottom moulding in plastic but has front and rear panels made of attractive anodised aluminium.

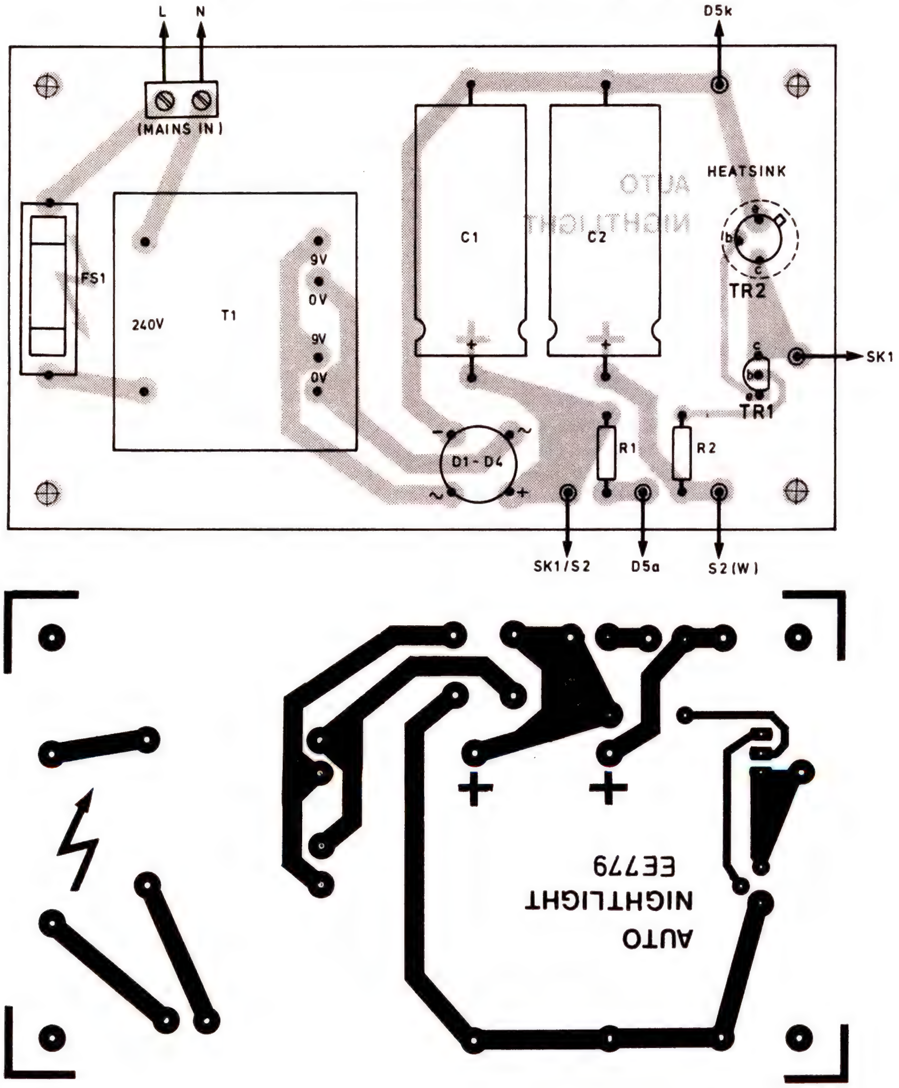
The layout of the components and full size copper foil master pattern is illustrated in Fig. 2. Even the fuse and mains transformer are p.c.b. mounted, thus reducing mains interwiring and making construction easier and safer.

It is best to start the assembly by soldering the smallest components into place, so start with the resistors and transistors, observing correct orientation of the transistor leads and taking care not to heat the semiconductors excessively. A push-on TO-5 type heatsink was fitted to TR2 to aid dissipation once the bulb starts to dim; it may be possible to omit the heatsink, otherwise fit it prior to soldering the device into place.

Follow on construction with the bridge rectifier D1-D4 and electrolytic capacitors, and here correct polarity is *essential.* Continue with the two-way p.c.b. screw terminal block, which forms the mains input for the board, then the p.c.b. fuseholder and finally the mains transformer T1.

There are differences between different makes of p.c.b. mains transformers, so it is obviously necessary to ensure that the unit purchased matches the p.c.b. pin layout. The transformer must sit snugly against the surface of the p.c.b. or damage to the copper track may result (the track could lift off eventually due to mechanical vibration).

Fig. 2. P.C.B. layout and wiring for the Nightlight.



CASE

Before completing the interwiring, it is necessary to prepare the aluminium front and rear panels of the box, dependent on the type of box purchased by the constructor. The rear panel is drilled to take the mains cable inlet, and this hole must be fitted with a grommet to prevent damage occurring to the cable insulation due to chafing. Further drilling is required for a

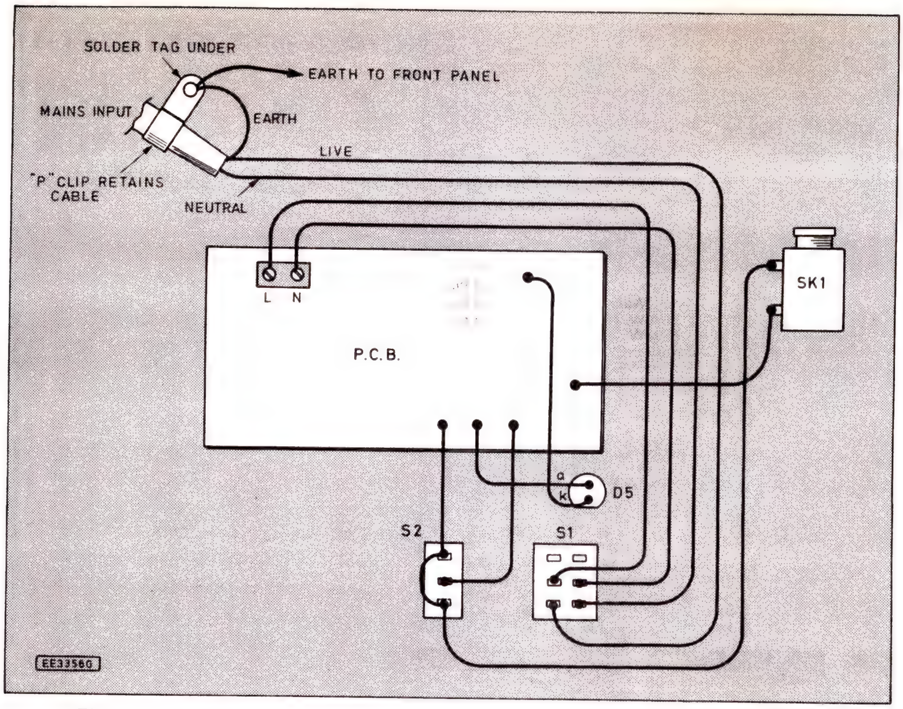


Fig. 3. Interwiring, the front and rear aluminium panels must be earthed.

"p" clip which retains the mains cable, and also a 6mm dia. hole will be required for the jack socket SK1.

The front panel is prepared to accept the toggle switches S1 and S2. If the specified switches are used, then two 6mm holes are needed. One final 6mm hole is required for the power-on indicator D5, which can be retained with an l.e.d. clip or lens bezel. If desired, the front panel can be embellished with rub-down lettering to label the controls, followed by a coat or two of protective clear lacquer.

Interwiring is completed in accordance with Fig. 3. Six amp three-core mains flex (e.g. 3 x 24/0.2mm) is employed for the mains inlet cable and the Earth input is connected via a solder tag to the "P" clip mounting bolt, in order to "ground" the rear panel. The front panel must also be Earthed for safety, and on the prototype this was achieved with an earthing wire (from the rear panel Earth tag) placed under one of the toggle switch mounting nuts.

LAMP UNIT

The lamp unit was constructed using a technique first used by the designer in *Everyday Electronics*, July 1978, no less! The lamp uses an aerosol top as a diffuser, see Fig. 4.

A batten-mounting M.E.S. bulbholder was fitted to a circular piece of 3mm plywood which had been cut to snap fit into the base of the aerosol top. A length of single-core screened cable (twin-core figure eight flex will work equally well) interconnects the lamp and the main unit, and was terminated in a 3.5mm jack plug to fit socket SK1.

Since long trailing cables at mains voltage are to be discouraged, it is best to have the mains flex as short as possible, say one metre long. But the lamp connecting wire, being at 12V d.c. can be as long as necessary, so the lamp can be positioned in any desired location.

FINAL CHECK

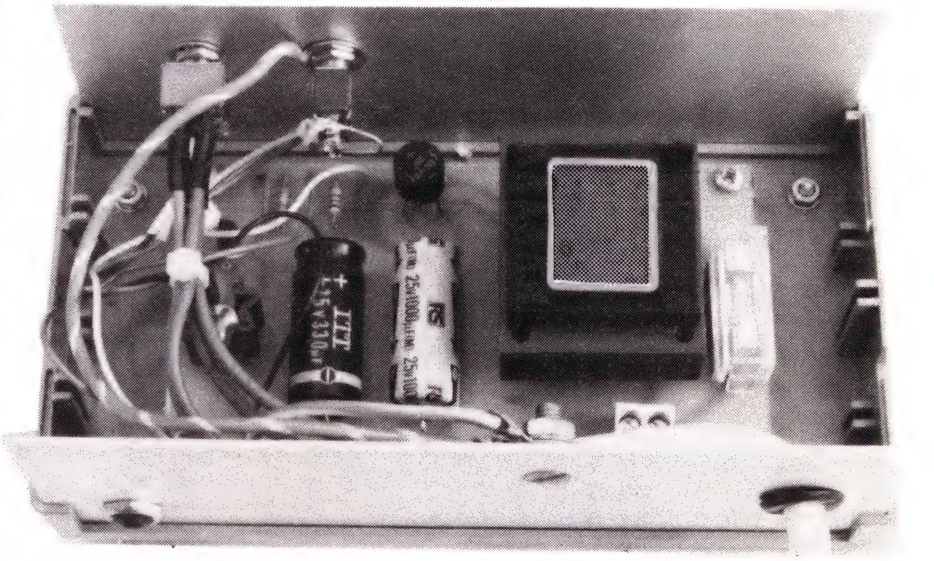
Complete the assembly of the Auto Nightlight by fitting a mains plug *fused 3A*, to the mains lead, and plug in the lamp unit to the jack socket SK1. Prior to plugging in and switching on, thoroughly check the unit for any wiring errors, particularly regarding the polarity of the electrolytic capacitors and transistors. With S1 set to "OFF", plug into the mains and switch on.

Operating switch S1 should illuminate the l.e.d. and by switching S2, the lamp should illuminate. It should stay alight even if switch S2 returns to the centre-off position.

It may be possible to time the period that elapses before the lamp gradually extinguishes. This should be about an hour or so.

As explained earlier, there is a large tolerance on capacitor C2 and if the time period is far too short or too long, then probably the easiest remedy is to raid the junk box and substitute C2 for another value (observing the *correct* voltage rating). Some trial and error may be required in extreme cases.

Finally, it is safe to connect a *second* lamp unit (12V 2.2W max.) in parallel with LP1 without any problems. Or substitute LP1 for a 5W lamp (car type), since there is adequate spare capacity on the transformer and also the output transistor. □



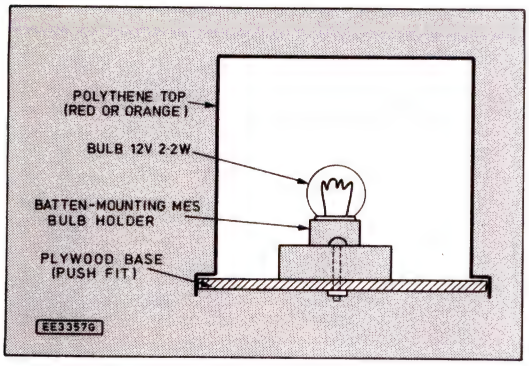
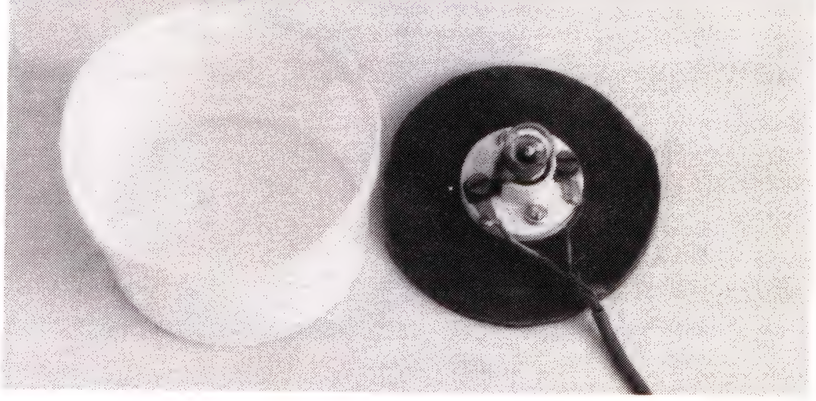

POLYTHENE TOP (RED OR ORANGE)
BULB 12V 2·2W
BATTEN-MOUNTING MES BULB HOLDER
PLYWOOD BASE (PUSH FIT)
EE3357G

Fig. 4. Lampholder made from the top of a large aerosol can.



ESR

ESR ELECTRONIC COMPONENTS

Station Road, Cullercoats,
Tyne & Wear NE30 4PQ
Tel. 091 251 4363 Fax. 091 252 2296

PCB EQUIPMENT

UV EXPOSURE UNIT – 229 x 159mm working area, built in timer, 2 x 8w tubes	**£62.57**
PHOTO RESIST BOARD – single sided pre-sensitised FR4 glass fibre board. 3 x 4 in. **£0.86** 4 x 6 in. **£1.62** 6 x 6 in. **£2.41**	
PLASTIC DEVELOPING TRAY	**£1.35**
FERRIC CHLORIDE (0.5Kg)	**£2.45**
TIN PLATING POWDER (90g)	**£8.33**
STRIPBOARD 0.1 pitch 64 x 127mm **£1.30** 64 x 431mm **£4.03** 95 x 127mm **£1.52** 95 x 95mm **£1.33** 95 x 431mm **£5.27**	
BREADBOARD 81 x 60mm 390TP **£2.98** 175 x 42mm 640TP **£3.40** 175 x 67mm 840TP **£5.34** *203 x 75mm 840TP **£7.00**	

* inc plate & 4mm posts

KITS

Complete with screen printed & solder mask board, components and full instructions.

CAR ALARM voltage drop	**£12.99**
200W CAR BOOSTER 12/24V CD/line/speaker input. inc housing.	**£91.88**
ELECTRONIC DICE (dual)	**£9.15**
SOUND GENERATOR 10 tunes, line & speaker output	**£19.11**
2.5W UNIVERSAL AMPLIFIER	**£6.86**
AF SIGNAL INJECTOR/TRACER adjustable o/p & i/p	**£8.39**
DIGITAL CODE LOCK 4 digit code flip/flop or latch o/p	**£19.11**
AC MOTOR/DRILL CONTROLLER carbon brush 24-240Vac 5A	**£15.28**

D CONNECTORS

	Plug	Socket
9 pin	**£0.29**	**£0.30**
15 Pin	**£0.39**	**£0.39**
15 Pin H.D.	**£0.81**	**£0.90**
25 Pin	**£0.48**	**£0.50**
9 Way plastic cover		**£0.30**
15 Way plastic cover		**£0.33**
25 Way plastic cover		**£0.36**

SOLDERING IRONS

Antex Soldering irons

M 12 Watt	**£7.11**
C 15Watt	**£7.11**
G 18Watt	**£7.30**
CS 17Watt	**£7.21**
XS 25Watt	**£7.30**
ST4 STAND	**£2.75**
New PORTASOL HOBBY 35Watt gas iron	**£11.17**
DESOLDER PUMP	**£3.00**
ANTISTATIC PUMP	**£4.30**
22SWG 0.5Kg Solder	**£7.40**
18SWG 0.5Kg Solder	**£6.60**
1mm 3 yds Solder	**£0.50**

AUDIO CONNECTORS

PHONO PLUG inc strain relief, Red or Black	**£0.17**
PHONO PLUG right angle, Red or Black	**£0.23**
PHONO Chassis Socket	**£0.16**
6.35mm Plastic Mono Plug with strain relief	**£0.25**
As above but Stereo	**£0.45**
6.35mm Chassis Socket, switched Mono **£0.36**, switched Stereo	**£0.49**
3.5mm Mono Plug	**£0.17**
3.5mm Stereo Plug	**£0.29**
3.5mm Mono line skt	**£0.24**
3.5mm Stereo line skt	**£0.29**
PLASTIC DIN PLUGS 2 pin **£0.15**, 5/360 **£0.27**, 3 pin **£0.24**, 6 pin **£0.30**, 4 pin **£0.29**, 7 pin **£0.33**, 5 /180 **£0.26**, 8 pin **£0.45**, 5 /240 **£0.30**	
XLR Chassis Socket	**£1.65**
XLR Chassis Plug	**£1.32**
XLR Line Socket	**£1.45**
XLR Line Plug	**£1.36**

HARDWARE

PCB Nylon Stand-offs clip into board, screw from base.
5mm spacing **£0.24**/10 **£1.68**/100
10mm spacing **£0.26**/10 **£1.82**/100
13mm spacing **£0.30**/10 **£2.10**/100
SELF TAPPING SCREWS Pan head
No 6 x 6.4mm **£0.14**/10 **£0.88**/100
No 6 x 9.5mm **£0.12**/10 **£0.78**/100
No 6 x 13mm **£0.13**/10 **£0.85**/100
No 6 x 19mm **£0.16**/10 **£1.04**/100

T2 Box 75 x 56 x 25mm	**£0.76**
T3 Box 75 x 51 x 25mm	**£0.72**
T4 Box 111 x 57 x 22mm	**£0.92**
MB1 Box 79 x 61 x 40mm	**£1.36**
MB2 Box 100 x 76 x 41mm	**£1.48**
MB3 Box 118 x 98 x 45mm	**£1.72**
MB5 Box 150 x 100 x 60mm	**£2.36**

REGULATORS

78L05, 78L12, 78L15	**£0.24**
79L05, 79L12, 79L15	**£0.28**
7805, 7812, 7815	**£0.28**
7905, 7912, 7915	**£0.38**
LM317T 1.5A 1.2-37V	**£0.44**
LM723 150mA 2-37V	**£0.29**

DIODES

Zener Diodes 2V7–33V	
BZY88 400mW	**£0.08**
BZX85 1.3W	**£0.14**
1N4001-1N4005	**£0.07**
1N4006-1N4007	**£0.08**
1N5400-1N5402	**£0.09**
1N5404-1N5406	**£0.11**
1N5407-1N5408	**£0.15**
1N4148 Signal	**£0.05**
OA90 Signal	**£0.07**
OA91 Signal	**£0.10**

THYRISTORS & TRIACS

PO102AA 0.8A 100V SCR	**£0.22**
TIC106D 5A 400V SCR	**£0.40**
TIC206D 4A 400V Triac	**£0.65**
BTA08-400BW 8A iso	**£1.74**

VELLEMAN KITS

Stockists of the full range of Velleman kits. Catalogue available upon request.

RESISTORS

0.25W 5% CF E12 Series	**£0.60**/100
0.5W 5% CF E12 Series	**£0.95**/100
0.25W 1% MF E24 Series	**£1.72**/100
POTS Log or Lin 470R – 1MO 25mm dia 0.25in shaft	**£0.40**
PRESETS Enclosed Horz or Vert 100R – 1MO 0.15W	**£0.15**
PRESETS Skeleton Horz or Vert 100R – 1MO 0.1W	**£0.11**

RF CONNECTORS

BNC Solder Plug	**£0.85**
BNC Crimp Plug	**£0.68**
BNC Solder Skt	**£1.08**
BNC Chassis Skt	**£0.78**
PL259 5.2mm	**£0.58**
PL259 11mm	**£0.58**
RND UHF socket	**£0.48**
SQR UHF socket	**£0.40**
F Plug RG58	**£0.27**
F Plug RG6	**£0.27**
N Plug RG8	**£1.64**

AUDIABLE WARNING

400Hz 75dB 9-20V	**£0.72**
450Hz 80dB 9-12V	**£1.14**
4KHz 90dB 3-15V	**£0.92**
2.8KHz 100dB pulsed	**£1.60**
3.5KHz 75dB 240Vac	**£1.22**
4KHz 80dB 30V pk-pk	**£0.58**

BRIDGE RECTIFIERS

W005 1.5A 50V	**£0.19**
WO2 1.5A 200V	**£0.20**
BR32 3A 200V	**£0.36**
BR62 6A 200V	**£0.64**
1004 10A 400V	**£1.39**

CAPACITORS

Ceramic Disc 100V 10pF to 100nF	**£0.07**
Ceramic Plate 100 & 63V 1.0pF to 12nF 1pF-1nF **£0.06**, 1n2-2n7 **£0.09**, 3n3-4n7 **£ 0.12**, 10n & 12n **£0.06**	
Polystyrene 160V 5% 47pF to 10nF 47p-2n2 **£0.09**, 2n7-10n **£0.12**	

★★NEW★STOP PRESS★NEW★★

★ REMOTE CONTROL RECEIVER & TRANSMITTER ★

Over 4000 possible codes ★ RANGE 40M (Approx.)

RECEIVER	TRANSMITTER
★ LED ON/OFF INDICATOR	★ TRANSMIT LED
★ 10A RELAY OUTPUT	★ KEY CHAIN STYLE CASE
★ MOMENTARY OR SWITCHED OUTPUT	★ BATTERY POLARITY PROTECTION
★ POWER SUPPLY: 2x9V AC OR 12-16V DC	★ POWER SUPPLY: 12V DC
★ £19.11	★ £12.21

★★★★★★★★★★★★★★★★★★★★

SWITCHES

SPST Toggle	£0.58
SPDT Toggle	**£0.54**
SPDT CO Tog	**£0.62**
DPDT Toggle	**£0.68**
DPDT CO Toggle	**£0.74**
DPDT mini slide	**£0.15**
Rotary Wafer 1P-12W, 2P-6W, 3P-4W, 4P-3W	**£0.78**
Key Switch SPDT	**£2.40**
Push to make	**£0.25**
Push to break	**£0.24**
Latching Push Sqr	**£0.58**
PCB Tact 6 x 6mm	**£0.25**

DIL SOCKETS

8 Pin	**£0.07**
14 Pin	**£0.11**
16 Pin	**£0.15**
18 Pin	**£0.15**
20 Pin	**£0.16**
24 Pin	**£0.19**
28 Pin	**£0.22**
40 Pin	**£0.25**

TEST EQUIPMENT

LOGIC PROBE cmos/ttl 20MHz LED & sound indication	**£7.72**
DM105 DIGITAL MULTIMETER 14 range 3.5 digit	**£24.49**
TM357 DIGITAL MULTIMETER 31 range 3.5 digit	**£39.00**
HM103S ANALOGUE MULTIMETER 19 range 10A, Battery test	**£11.16**
CS4025 KENWOOD OSCILLOSCOPE Dual 20MHz inc switched probes (extra carriage charge)	**£299.00**

ADAPTORS

BNC Plug – PHONO Skt	**£0.78**
BNC Plug – BNC Plug	**£1.96**
BNC Skt – BNC Skt	**£1.00**
BNC Plug – UHF Skt	**£1.38**
BNC Plug – 2 x BNC Skt	**£1.89**
BNC Skt – 2 x BNC Skt	**£1.89**
UHF Plug – BNC Skt	**£1.59**
F Socket – F Socket	**£0.33**
3.5mm Plug – 2 x Skt	**£1.20**
3.5mm Plug – .25in Skt	**£0.57**
0.25in Plug – 3.5mm	**£0.57**

LINEAR ICs

TL071CP	**£0.32**
TL072CP	**£0.34**
TL074CN	**£0.48**
TL081	**£0.29**
TL082CP	**£0.34**
TL084CN	**£0.46**
TBA120S	**£0.60**
LM301A	**£0.25**
CA311E	**£0.28**
CA324	**£0.23**
LM348N	**£0.31**
LF351N	**£0.36**
LM358N	**£0.27**
LM377	**£2.57**
LM380N	**£1.12**
LM381	**£2.70**
LM386	**£0.48**
LM387	**£1.60**
LM392N	**£0.79**
LM393N	**£0.28**
CA555	**£0.22**
NE556N	**£0.36**
NE567N	**£0.36**
UA733	**£0.64**
CA741CE	**£0.18**
LM748CN	**£0.31**
TBA810S	**£0.68**
TBA820M	**£0.39**
LM1458	**£0.26**
ULN2004	**£0.48**
TDA2030	**£1.35**
CA3046	**£0.37**
CA3080	**£0.72**
CA3130	**£0.98**
CA3140	**£0.44**
CA3240	**£1.22**
LM3900	**£0.72**
LM3914	**£2.70**
LM3915	**£2.70**
MC4558	**£0.36**
NE5532	**£0.80**
ICL7621	**£1.70**

4000 Series

4000	**£0.20**
4001	**£0.17**
4002	**£0.19**
4006	**£0.32**
4007	**£0.20**
4008	**£0.31**
4010	**£0.19**
4011	**£0.16**
4013	**£0.17**
4014	**£0.30**
4015	**£0.31**
4016	**£0.18**
4017	**£0.25**
4018	**£0.27**
4022	**£0.32**
4024	**£0.21**
4025	**£0.15**
4026	**£0.40**
4027	**£0.18**
4029	**£0.27**
4030	**£0.17**
4033	**£0.56**
4035	**£0.31**
4040	**£0.29**
4042	**£0.22**
4046	**£0.31**
4047	**£0.25**
4049	**£0.20**
4051	**£0.25**
4052	**£0.25**
4053	**£0.24**
4055	**£0.30**
4060	**£0.31**
4063	**£0.29**
4066	**£0.18**
4069	**£0.20**
4072	**£0.17**
4075	**£0.17**
4076	**£0.30**
4077	**£0.15**
4082	**£0.17**
4089	**£0.55**
4093	**£0.15**
4094	**£0.31**
4095	**£0.56**
4510	**£0.26**
4511	**£0.29**
4515	**£0.78**
4520	**£0.26**
4521	**£0.84**
4534	**£2.48**
4538	**£0.37**
4541	**£0.31**
4572	**£0.25**
4584	**£0.24**
4585	**£0.48**
40106	**£0.24**
40174	**£0.34**

CONNECTORS

CROC CLIPS 33mm Red or Black	**£0.12**
CROC CLIPS 45mm Red or Black	**£0.20**
PP3 Battery Snap	**£0.10**
PP9 Battery Snap	**£0.14**
4mm BANANA PLUG Red or Black	**£0.09**
4mm BUNCH PIN PLUG Red or Black	**£0.30**
4mm BINDING POST Red or Black	**£0.54**
SCART PLUG	**£0.60**
SCART PCB Skt	**£0.78**
SCART LINE Skt	**£1.35**
IEC LINE SOCKET	**£0.78**
IEC CHASSIS PLUG	**£0.72**
IEC CHASSIS Skt	**£0.56**
CAR AERIAL PLUG	**£0.19**
CIGAR LIGHTER PLUG	**£0.30**

TRANSISTORS

BC107	**£0.14**
BC108A	**£0.12**
BC109C	**£0.15**
BC177	**£0.16**
BC178	**£0.16**
BC179	**£0.16**
BC182LB	**£0.09**
BC183LB	**£0.09**
BC184L	**£0.11**
BC212L	**£0.09**
BC212LB	**£0.09**
BC213LC	**£0.09**
BC214	**£0.11**
BC327	**£0.12**
BC328	**£0.10**
BC337	**£0.12**
BC338	**£0.08**
BC527	**£0.24**
BC528	**£0.24**
BC537	**£0.24**
BC538	**£0.24**
BC547C	**£0.09**
BC548C	**£0.08**
BC549C	**£0.10**
BC557C	**£0.09**
BC558C	**£0.09**
BC559C	**£0.09**
BDX33C	**£0.46**
BDX34C	**£0.54**
BFY50	**£0.24**
BFY51	**£0.24**
BFY52	**£0.24**
TIP29C	**£0.33**
TIP30C	**£0.33**
TIP31C	**£0.33**
TIP32C	**£0.34**
TIP33C	**£1.02**
TIP41A	**£0.36**
TIP42C	**£0.28**
2N2222	**£0.16**
2N2905A	**£0.28**
2N3704	**£0.09**
2N3705	**£0.09**
2N3706	**£0.09**
2N3771	**£1.22**
2N3772	**£1.28**
2N3773	**£1.88**
2N3904	**£0.10**
2N3905	**£0.10**
2N3906	**£0.09**

74LS-Series

74LS00	**£0.14**
74LS01	**£0.17**
74LS02	**£0.18**
74LS03	**£0.17**
74LS04	**£0.14**
74LS05	**£0.17**
74LS08	**£0.17**
74LS09	**£0.17**
74LS10	**£0.17**
74LS11	**£0.17**
74LS12	**£0.16**
74LS20	**£0.16**
74LS21	**£0.16**
74LS26	**£0.16**
74LS30	**£0.17**
74LS32	**£0.17**
74LS37	**£0.16**
74LS42	**£0.25**
74LS51	**£0.19**
74LS86	**£0.20**
74LS92	**£0.40**
74LS93	**£0.25**
74LS107	**£0.30**
74LS109	**£0.21**
74LS123	**£0.40**
74LS125	**£0.21**
74LS133	**£0.22**
74LS138	**£0.24**
74LS153	**£0.25**
74LS154	**£0.90**
74LS157	**£0.25**
74LS164	**£0.26**
74LS165	**£0.53**
74LS175	**£0.24**
74LS191	**£0.24**
74LS193	**£0.24**
74LS367	**£0.21**
74LS374	**£0.32**

RELAYS

6V SPDT 6A	**£0.70**
12V SPDT 6A	**£0.70**
6V DTDP 6A	**£1.96**

RECHARGEABLE BATTERIES

AAA Ni Cad	**£1.20**
AA Ni Cad	**£1.00**
C Ni Cad	**£2.40**
D Ni Cad	**£2.46**
PP3 Ni Cad	**£4.10**

BATTERY CHARGER

Plug-in 5 Hour charger, 4 x AAA or 4 x AA or 2 x PP3	**£5.43**

TOOLS

NEON SCREWDRIVER 140mm	**£0.75**
CRAFT KNIFE 150mm	**£1.00**
★ SIDE CUTTERS 115mm	**£2.40**
★ END CUTTERS 100mm	**£2.40**
★ SNIPE NOSE PLIERS 130mm	**£2.40**
# T3773 SIDE CUTTERS	**£15.48**
# T3780F SIDE CUTTERS	**£16.57**
# T3778F OBLIQUE CUTTER	**£19.97**
# T3798F OBLIQUE CUTTER	**£19.97**
# T3767 BENT NOSE	**£13.31**
# T3770 FLAT NOSE	**£12.44**
# T3771 ROUND NOSE	**£12.73**
# T3777 LONG NOSE	**£14.40**

★ sprung jaws, pvc handles
CK box joint, leaf sprung & induction hardened.

ELECTROLYTIC RADIAL CAPACITORS

uF	16V	25V	63V	100V
0.47	–	–	**£0.05**	**£0.07**
1.0	–	–	**£0.05**	**£0.06**
2.2	–	–	**£0.05**	**£0.06**
4.7	–	–	**£0.05**	**£0.08**
10	**£0.05**	**£0.05**	**£0.06**	**£0.08**
22	**£0.05**	**£0.05**	**£0.09**	–
47	**£0.06**	**£0.06**	**£0.11**	–
100	**£0.06**	**£0.09**	**£0.11**	–
220	**£0.09**	**£0.12**	**£0.31**	–
470	**£0.15**	**£0.19**	**£0.57**	–
1000	**£0.22**	**£0.29**	–	–
2200	**£0.37**	**£0.57**	–	–
4700	–	**£1.11**	–	–

POWER SUPPLY

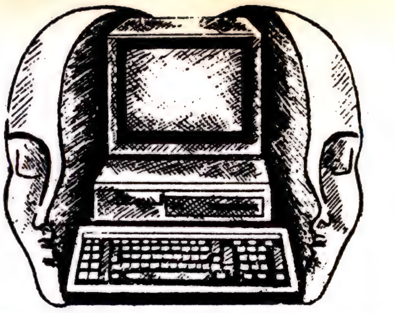
Plug in PSU 300mA non regulated, 3,4.5,6,7.5, 9 & 12V	**£3.88**

ORDERING INFORMATION

All prices exclude VAT. Please add 85p carriage to all orders and VAT (17.5%).
No minimum order charge.
Please send payment with your order
PO/Cheques made payable to
ESR Electronic Components
Access & Visa cards accepted
Offical orders from schools & colleges welcome.

CALL IN – OPEN: MON 8.30-5.00 SAT 10.00-5.00

INTERFACE



Robert Penfold

THIS month we return to the subject of PC interfacing, and a simple 8-bit analogue to digital converter that can be used in a multitude of applications. These include such things as voltage, resistance, and temperature measurement. An analogue to digital converter must be one of the most useful add-ons for a computer, as it enables you to measure and monitor all manner of things with the aid of some simple circuits.

There are a number of suitable analogue to digital converters to choose from when selecting one for use with PCs. Some, such as certain devices in the ADC08** series, are specifically designed to operate in conjunction with 8080 or 8088 style buses. They have read and write inputs that are compatible with the IOR and IOW lines of the PC control bus. These devices should interface easily to the PC expansion bus, and in my experience there is no difficulty in getting them to work properly with a PC.

The ZN448E

On the other hand, there are several analogue to digital converters which are not specifically designed for a PC type bus, but which are microprocessor compatible. Most of these will also interface to the PC expansion bus quite easily. The device I have selected for this interface is a chip from this second category, and it is the Ferranti ZN448E. This device has been popular for use with 8-bit computers for a number of years now, and many *Everyday Electronics* readers have no doubt used it in add-ons for the Spectrum, BBC model B, etc. It seems to work with the PC every bit as well as with these popular eight bit computers.

Pinout details for the ZN448E are shown in Fig. 1. This is a convenient chip to use as it is microprocessor compatible, has a built-in clock oscillator, and also incorporates a very high quality 2.55 volt reference source. The latter sets the full scale sensitivity at 2.55 volts, or 10 millivolts (0.01 volts) per bit in other words. It is not mandatory to use the built-in voltage reference as there are separate reference inputs and outputs, but in practice there is not usually any point in using a discrete reference generator. If you should decide to do so, the reference voltage should be between 2 and 3 volts.

It should perhaps be explained that the ZN448E is one device from a series of three. These are the ZN447E, ZN448E, and ZN449E. The only difference between these three chips are their guaranteed accuracies. The maximum errors are as follows:

ZN447E	± 0.25 LSB
ZN448E	± 0.5 LSB
ZN449E	± 1 LSB

For most purposes the ZN448E is probably the best choice, and this is the only version offered by some suppliers. Where optimum accuracy is essential the ZN447E can be used, but this is much more expensive. For many applications the cheaper ZN449E would probably suffice, but this version seems to be difficult to obtain these days.

Basic Converter

The circuit diagram for the Analogue to Digital Converter is shown in Fig. 2. R1 is the "tail" resistor for the voltage comparator at the input of the device. I will not give details of the way in which the ZN448E functions, as this has been covered several times in EE over the years. It is a successive approximation converter, and it has a high speed comparator at the input. This requires a negative supply in order to compare voltages right down to the 0 volt supply rail. This represents no problem in a PC context as there are two negative supply rails available. In this case the – 5 volt supply has been used. The current drain from this supply is insignificant at about 60 to 70 microamps.

Clock Oscillator

Components R2 and C1 are the discrete load resistor and decoupling capacitor for the internal voltage reference. C2 is the only discrete component needed in the clock oscillator circuit, and this is used to set the desired clock frequency. A value of 82p sets the clock at approximately 1MHz, which is the highest frequency at which the ZN448E is guaranteed to operate properly.

In practice, most ZN448Es seem to function perfectly well at significantly higher frequencies. Where very fast sampling rates are required, you can therefore try experimenting with lower values for C2 in order to determine the lowest value that gives acceptable results.

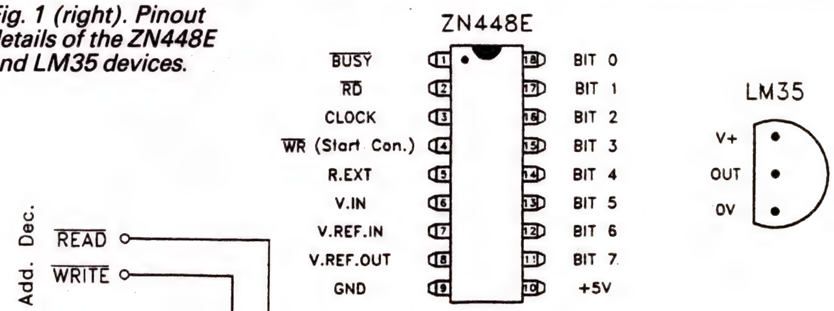
Nine clock cycles are required per conversion, and the converter is thus guaranteed to be able to complete each conversion in no more than 9µs. Most ZN448Es seem able to complete conversions in something more like 6µs. Either way, the conversion rate can be well over one hundred thousand per second, which is sufficient for applications such as audio digitising.

Conversion

In order to start a conversion a dummy value is written to the converter. The value written is unimportant, since it is actually the "write" pulse from the address decoder that initiates the conversion. The ZN448E cannot read the data bus – it can only output data onto it.

PC address decoders will not be considered here, as they have been covered in recent *Interface* articles. The main point to note here is that the address decoder must process the IOR and IOW lines of the

Fig. 1 (right). Pinout details of the ZN448E and LM35 devices.



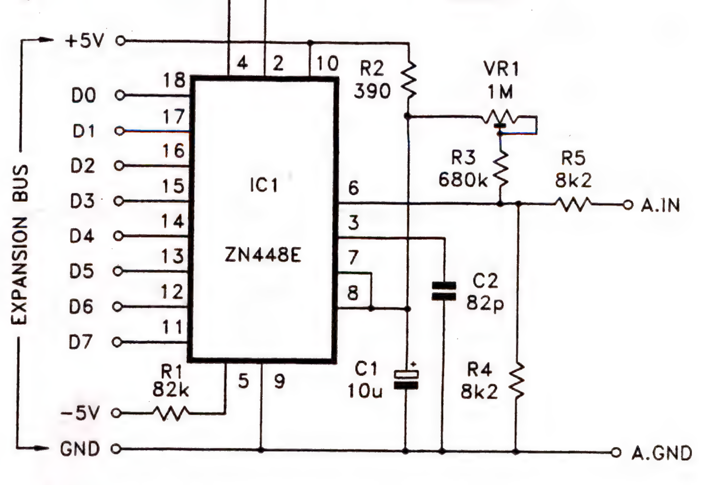


Fig. 2. Circuit for the Analogue to Digital converter.

expansion bus, so as to provide separate "read" and "write" outputs. The circuit of Fig.1 from the *Interface* article in the August 1991 issue is suitable, but the extra gating shown in Fig.3 is needed.

It is essential that the converter is not read before a conversion has been completed. A suitable hold-off can be achieved by monitoring the "Busy" output of IC1, which goes low when a conversion is in progress. However, as the time taken for each conversion is very much the same, a timing loop offers a more simple solution. This avoids the need for a digital input port to monitor the "Busy" line, but a little experimentation might be needed in order to find the optimum delay time.

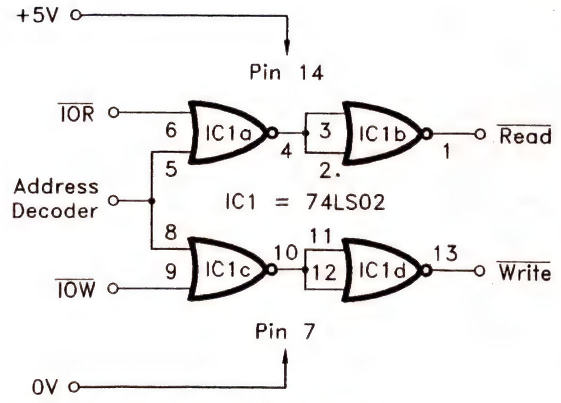


Fig. 3. Address decoder extra gating.

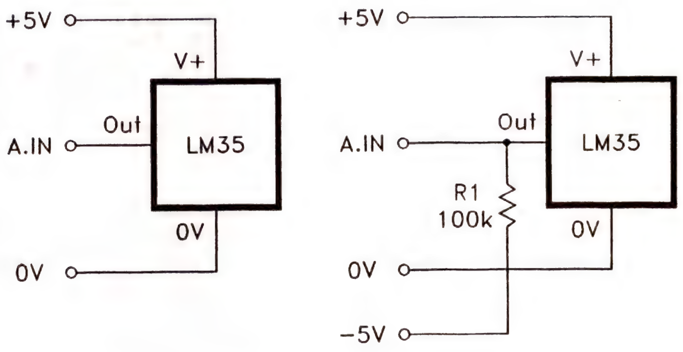


Fig. 4. Two basic methods of using the LM35.

In many cases readings will only be taken infrequently anyway, and quite a long delay can then be used. Note that with interpreted BASICs such as GW BASIC, or the QBASIC interpreter supplied with MS/DOS 5.0, it is unlikely that even the fastest of PCs could operate fast enough to take premature readings.

The ZN448E has tristate outputs which are activated by a read operation from a suitable input address. These outputs seem to be well able to keep up with the expansion bus without any need for added wait states. As a point of interest, I have recently tried interfacing a number of peripheral chips to the PC, and not one of them needed any added wait states.

Zero Adjustment

For optimum results a zero adjustment circuit is needed on the input side of the converter. This is the purpose of the three fixed resistors and variable resistor VR1. The latter is the zero adjustment potentiometer. This network also acts as an attenuator to reduce the sensitivity of the circuit to the desired level.

In this case the full scale sensitivity is about 5 volts, but for precise results R5 would have to be replaced with a 4k7 fixed resistor in series with a high quality 4k7 preset resistor. The preset would then be adjusted for a full scale sensitivity of precisely 5 volts. The values of R4 and R5 can be altered to produce other full scale sensitivities, but the parallel resistance of these two resistors should always be about 4k.

For zero adjustment a potential of about 10 millivolts (i.e. 0.5 LSB) must be applied to the input of the circuit. This can be provided by a potential divider connected across the +5 volt and 0 volt supplies. Suitable values are 5k1 for the upper arm and 10 ohms for the lower section. With a continuous stream of readings taken, VR1 is adjusted so that the readings fluctuate between 0 and 1. The offset if no zero adjustment is used is not very large, and in some applications there may be no point in bothering with the zero adjustment circuit.

Temperature Sensors

There are now numerous temperature sensing devices available. For a computer temperature interface some of the integrated circuit temperature sensors are ideal. In particular, the LM35 is not too expensive, but is quite accurate and very easy to use. This provides an output potential that is equal to 10 millivolts per degree Centigrade. Fig.1 includes leadout details for the LM35, which is contained in an ordinary TO-92 style plastic encapsulation. Fig.4 shows the two basic ways this device can be used.

The first method is the most basic one, where the LM35 is simply fed with a suitable supply voltage and the appropriate output voltage is produced. The supply potential can be anything from 4 to 30 volts, so the PC's +5 volt supply is suitable.

With an LM35CZ this gives a useful operating range of 2 to 110 degrees Centigrade. The LM35DZ is substantially cheaper, and provides a useful range of 2 to 100 degrees Centigrade.

The second method requires a negative supply and an additional resistor. With an LM35DZ this increases the useful operating range to 0 to 100 degrees Centigrade. The improvement with the LM35CZ is even more impressive, it can handle temperatures from −40 to +100 degrees Centigrade using this method. Note though, that negative temperatures produce negative output voltages. Some level shifting would be needed in order to enable the converter to bring these within the input voltage range of the converter.

A very simple way of using these circuits with the A/D converter is to simply connect the output direct to pin 6 of the ZN448E, and to omit R3, R4, R5, and VR1. This will not give particularly accurate results at low temperatures, although in practice it seems to work rather better than the theory would dictate.

The temperature sensor provides an output of 10 millivolts per degree Centigrade, and the converter has a resolution of 10 millivolts. This method is therefore very convenient in that readings from the converter are directly in degrees Centigrade.

There is a severe problem with this system in that readings will never exceed 110, which means that the converter is effectively only operating as a seven bit type. A resolution of only one degree Centigrade is obtained, whereas the converter is capable of a 0.5 degree resolution over a 0 to 110 degree temperature range. With suitable signal conditioning it is possible to obtain better accuracy and resolution, which is one of the topics we will pursue in next month's *Interface* article.

EVERYDAY ELECTRONICS BINDERS

Don't let your valuable issues of EE get binned, burned or bitten (by the dog). Get one of our exquisite orange hard-back binders, slip each issue into it as you get them and you will always know where they are– we hope!

Binders to hold one volume (12 issues) are available from Everyday Electronics, 6 Church Street, Wimborne, Dorset BH21 1JH for £5.95 (£6.95 to European countries and £9.00 to other countries, surface mail) inclusive of postage and packing. **Payment in £ sterling only please. Visa and Access (MasterCard) accepted, minimum credit card order value £5.**

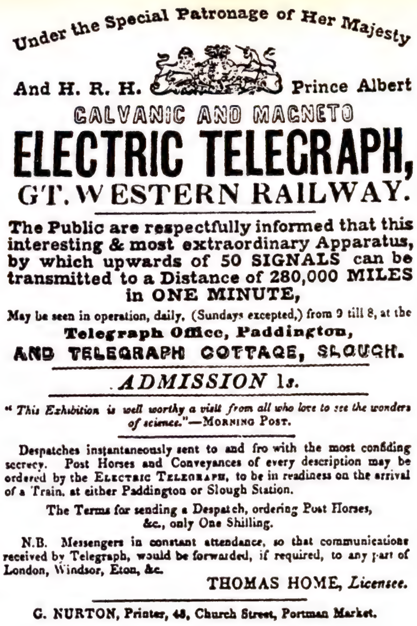
Binders are normally sent within seven days of receipt of your order but please allow up to 28 days for UK delivery – more overseas.

Special Series

INFORMATION TECHNOLOGY

AND THE NATIONAL CURRICULUM

T. R. de VAUX BALBIRNIE — PART 2



Under the Special Patronage of Her Majesty

And H. R. H. Prince Albert

GALVANIC AND MAGNETO

ELECTRIC TELEGRAPH,

GT. WESTERN RAILWAY.

The Public are respectfully informed that this interesting & most extraordinary Apparatus, by which upwards of 50 SIGNALS can be transmitted to a Distance of 280,000 MILES in ONE MINUTE,

May be seen in operation, daily, (Sundays excepted,) from 9 till 8, at the

Telegraph Office, Paddington,

AND TELEGRAPH COTTAGE, SLOUGH.

ADMISSION 1s.

"This Exhibition is well worthy a visit from all who love to see the wonders of science."—MORNING POST.

Despatches instantaneously sent to and fro with the most confiding secrecy. Post Horses and Conveyances of every description may be ordered by the ELECTRIC TELEGRAPH, to be in readiness on the arrival of a Train, at either Paddington or Slough Station.

The Terms for sending a Despatch, ordering Post Horses, &c., only One Shilling.

N.B. Messengers in constant attendance, so that communications received by Telegraph, would be forwarded, if required, to any part of London, Windsor, Eton, &c.

THOMAS HOME, *Licensee.*

G. NURTON, Printer, 48, Church Street, Portman Market.

THIS is the second article in a 12-part series concerning Communication, Information Technology and related matters in the Science National Curriculum. This month we shall look at some of the history of long-range communication and give further suggestions for practical work. This will illustrate how electricity has helped man to achieve long-range communication efficiently and conveniently. Next month, we shall look at the topic of information storage.

Readers who have not been following the series are advised to read Part 1 in last month's issue to see how this fits into the scheme of the original and modified Attainment Targets within the National Curriculum.

Children should first be shown that electricity needs a *circuit* in which to flow. That is, it needs a complete path from one terminal of a battery to the other through components which *conduct* electricity – copper wire, bulbs and so on. Use the simple series circuit shown in Fig. 1. This consists of a PP3 battery, battery connector and a 6V 0.06A bulb in a lamp holder.

If a break is made in the circuit (for example, by unscrewing the bulb), the light goes off. If a break is made in one of the connecting wires and the end 10mm or so of insulation removed from each end, the wires may be touched together to light the bulb – this forms a simple switch. All components for this and the other experiments may be obtained cheaply from a mail-order electronics supplier.

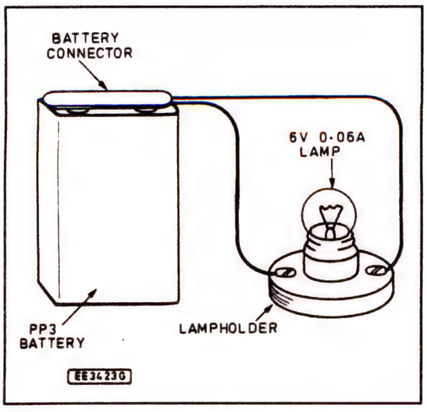


Fig. 1. A simple electrical circuit providing a complete path from one battery terminal to the other.

THE ELECTRIC TELEGRAPH

The Chappe telegraph (described last month) was an *optical* system – it used a visual method to send messages. However, here we are concerned with the *electric* telegraph. This was so important in the history of long-range communication that some time could be devoted to this topic alone.

In the electric telegraph, an operator would make and break an electrical circuit using a code to represent the letters of the alphabet. These signals would pass along the telegraph line and be decoded by another operator at the distant end. The same line could be used to send signals the other way to give a reply.

Although there had been some early experiments in electrical telegraphy, the first "serious" device was not produced until 1837. The messages were decoded by observing the positions of moving pointers (see photograph of *the Cooke and Wheatstone 5-needle telegraph*). The telegraph was further developed by an American, Samuel Morse, who erected his first telegraph line between Washington and Baltimore in 1844. He invented the now famous Morse Code – a series of dots and dashes representing the letters of the alphabet – to send messages (the Morse Code was reproduced in last month's issue).

The messages were sent using a "Morse key". This is a type of switch whose contacts complete a circuit when a knob is pressed – a long press gives a "dash" and a short one a "dot". The most used letters were given the simplest codes. In the English language the letter "E" is the one most used so this is given the simplest code of all – a single dot. As well as all the letters of the alphabet, the Morse code may be used to signal punctuation marks, numbers, etc.

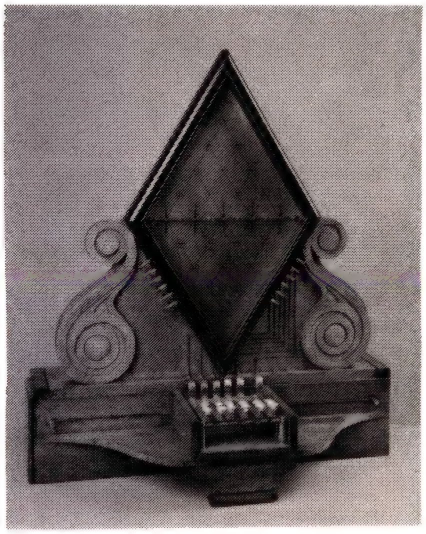
Telegraphy quickly became the principle means of long-range communication with every town of note having its own telegraph office from which messages could be sent and received. The Morse telegraph was soon used to send messages to and from France through a cable laid in the English Channel in 1851.

Soon it became possible to send telegraphic messages between Britain and the United States. For this, a cable had to be laid some 300km in length. This was duly carried out in 1857-8 with the best materials then available for the job. Unfortunately, after just a few hundred messages, the cable broke.

The telegraph was the forerunner of all modern communications systems – since it sent information so quickly, it seemed to make the world a smaller place. The photograph above shows a contemporary poster inviting the public to see the wonder of the age in action.

A HOME-MADE TELEGRAPH

Refer to Fig. 2 and make a Morse key – alternatively, use a real one or a small momentary-action switch from a basic electricity kit. Even a bell-push could be used.



The Cooke and Wheatstone 5 – needle telegraph.

(Reproduced by permission of the Trustees of the Science Museum).

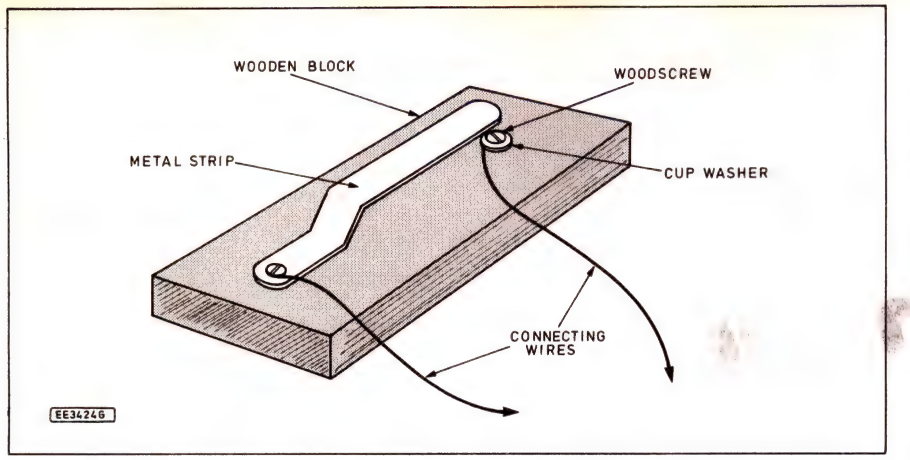


Fig. 2. Construction of a simple Morse key.

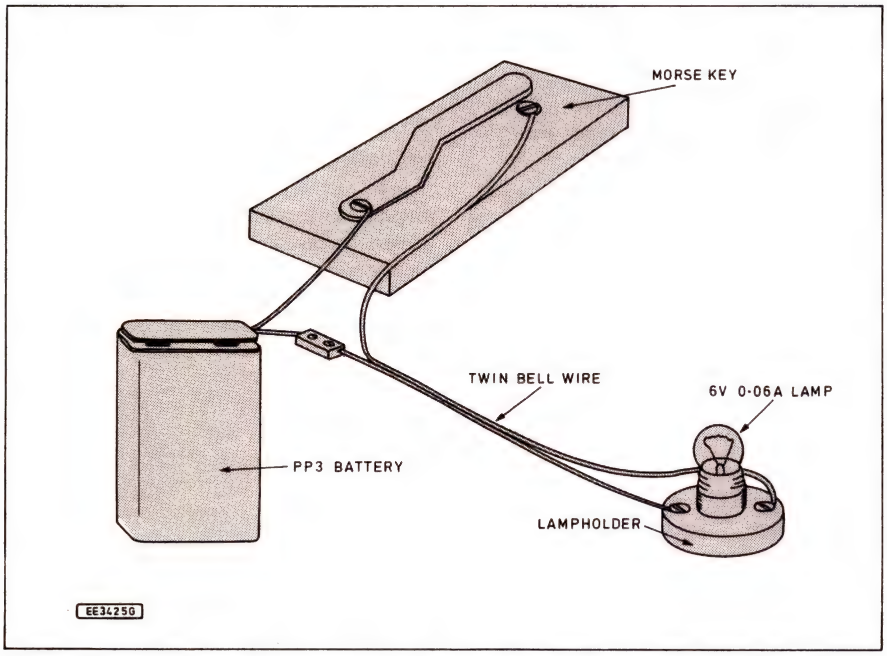


Fig. 3. Series circuit for use with the Morse key.

For the home-made Morse key you will need the following parts:

1 piece of wood 100 x 50 x 15 mm approximately
2 off size No 4 round headed brass woodscrews 12 mm (½ in) long
2 cup washers to fit the woodscrews
Strip of metal (brass, copper or tinplate)
12 mm wide x 80 mm long

You will also need some light-duty twin wire ("bell wire") approximately 20m long, a 6V 0·06A bulb in a lamp holder, a PP3 battery and connector and one section of 3A screw terminal block.

Drill a hole in one end of the metal strip large enough for one of the woodscrews to pass through then bend the metal as shown in the diagram. Drill a pilot hold and partly insert one of the screws in the wood with a cup washer under its head. Strip the end 10mm of insulation from each wire and twist one of them round the woodscrew so that it is gripped by the cup washer when the screw is tightened.

Secure the metal strip in the same way with the second wire gripped under its washer. Check that the metal strip can be pressed so that it makes contact with the woodscrew. It is important that the area of metal making contact with the screw is clean.

Use the PP3 battery, bulb and Morse key to make a series circuit – see Fig. 3. Check that the bulb may be flashed by pressing the key to make dots (short presses) or dashes (longer presses). A buzzer could be substituted for the bulb – use a 6V solid-state buzzer. This will cost approximately 50p.

Children may investigate how far they can communicate using the home-made telegraph. The speed at which messages can be sent and received may be compared with that of modern devices such as the telephone. It must be remembered, however, that telegraph operators became very proficient at using the Morse key.

Soon the telegraph was made automatic so that it produced dots and dashes on a piece of moving paper tape by means of a pen which would rise and fall with the incoming signal. This could be deciphered later. Thus, the information was *stored*. This concept of storage is important and information storage will be discussed in more detail next month.

Since one pair of wires could carry only one message at a time, the telegraph office was often very busy. To send more messages, high speed techniques were invented. In one system, the message was first turned into a series of long and short holes in paper tape. The tape could then be fed through a special machine at high speed. This would switch the current on and off at a much higher rate than would be possible using a Morse key. At the distant end, the code of dots and dashes was printed on to a piece of moving tape by means of the rising and falling pen described earlier. In this way, the telegraph line was able to carry a lot more messages in a given time and thus reduce costs.

THE TELEPHONE

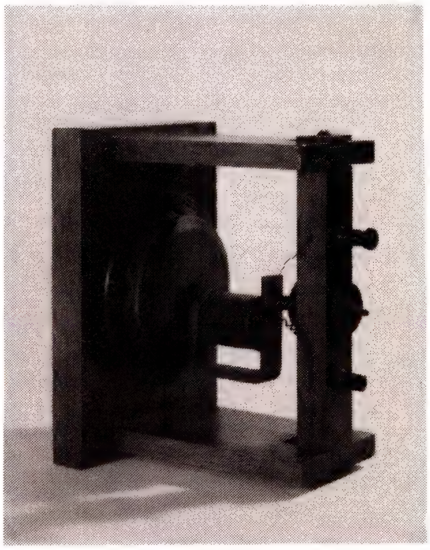
There had been some early experimentation with the telephone – that is, a device which would turn the human voice into electrical signals then back into intelligible speech. The results were, however, very indistinct. The Scottish scientist, Alexander Graham Bell, invented a true working telephone in 1876 (see photograph). With this, he succeeded in sending the spoken word in the form of electrical signals along wires instead of merely dots and dashes as in the telegraph.

The telephone quickly overtook the telegraph in terms of speed and convenience. The telephone had the personal touch lacking in the telegraph in that actual voices were heard. It also provided instant two-way conversation which was not possible with the telegraph.

A HOME-MADE TELEPHONE

This experiment simulates Bell's original telephone apparatus using loudspeakers. You will need two miniature loudspeakers and a long piece (about 20 metres) of bell wire. The best type of loudspeakers to use have a diameter of approximately 60mm and an impedance of 60 to 80 ohms. You should not pay more than about 50p each for these.

This experiment works best when the loudspeakers are used as they are. However, they will then need to be used very carefully to avoid damage. In practice,



Bell's experimental telephone.
(Reproduced by permission of the Trustees of the Science Museum).

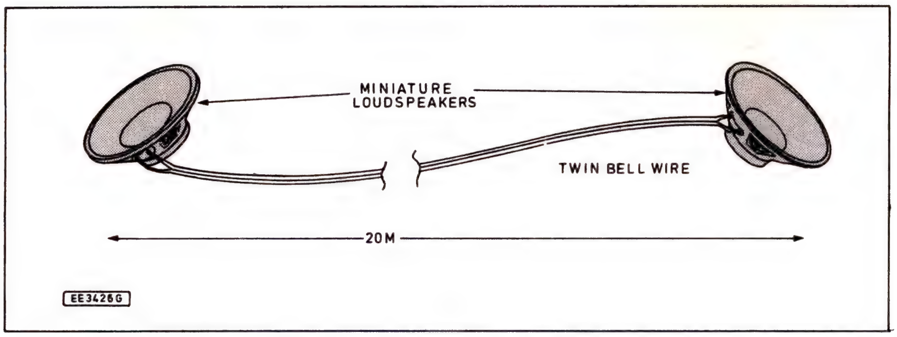


Fig. 4. Using miniature loudspeakers as a crude telephone.

you may need to use some sort of protection – perforated boxes, for example. The children should have an opportunity to look at the paper cone and see that it moves backwards and forwards – take care, though, because this part is very fragile. They will remember from last month that sound is caused by vibrations.

Touch the terminals of one of the loudspeakers briefly on to the terminals of the PP3 battery and a click will be heard. If a few light objects such as small pieces of paper are placed on the cone, they will jump when the battery is connected. This will reinforce the idea that electrical signals may be turned into sound and that sound is caused by vibration. The opposite effect is also true – if the cone is made to vibrate, an electrical signal is produced.

Connect the two loudspeakers together using the bell wire (see Fig. 4). The wires may be twisted carefully on to the terminals, soldered or miniature crocodile clips used. Touch the metal frame of one loudspeaker with a sounding tuning fork (the prongs of a dinner fork may do). If a child listens to the cone of the other loudspeaker, a copy of the original sound will be heard. This was roughly the way Bell's original telephone worked.

Note that no battery is used – the first loudspeaker turns the sound vibrations into electrical signals and the second one turns the electrical signals back into sound. Children find it difficult to believe that electrical signals can be produced without using a battery.

Use the circuit above to see if the children can talk to one another using the home-made telephone. One person goes into a distant room and speaks closely into one loudspeaker. The other listens carefully to the other one. The experiment works best when the children cannot hear one another directly. It should be possible to hear speech, albeit rather faintly. The listener and the speaker now change roles.

In this experiment, the loudspeakers are being used for two purposes just as in Bell's original apparatus. One is acting as a *microphone* while the other is being used as an *earpiece*. The disadvantage of this method is that the electrical signal is very weak and is reduced still further by long wires. The original telephone could only be used successfully over relatively short distances. Even so, it will work over much greater distances than the string telephone described last month.

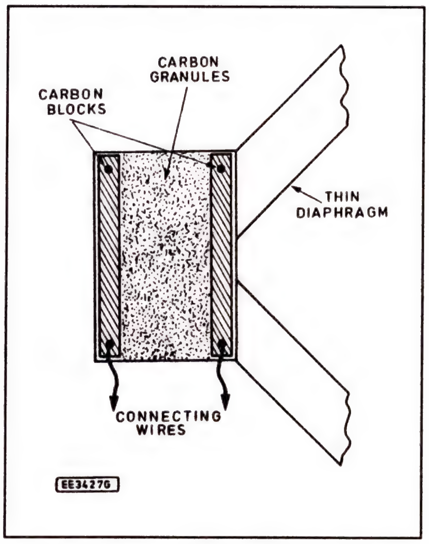


Fig. 5. A carbon microphone as used in later telephones.

TELEPHONE DEVELOPMENT

The telephone was further developed to provide a greater range. A "carbon" microphone (see Fig. 5) was used in combination with an earpiece which worked like one of the miniature loudspeakers. The microphone consisted of a small box containing carbon granules with a carbon block at each end. Carbon is a conductor of electricity (it allows electricity to pass through it). When the granules vibrate due to sound falling on the microphone diaphragm, they will allow electricity to flow between the carbon blocks more or less easily according to whether they are pushed together or allowed to move apart.

A circuit is made using a carbon microphone, earpiece and battery. When the caller speaks near the microphone diaphragm, the carbon granules vibrate. The current flowing is then an electrical copy of the voice patterns. When this changing electrical signal flows through the earpiece at the other end, its diaphragm vibrates with the same pattern so duplicating the original sound,

If any reader wishes to try this out as an experiment, the best way is to obtain a carbon granule microphone from an old dial-type telephone handset. This is easier than making one, although this would be possible. One of the miniature loudspeakers would be suitable to use as the earpiece. A much louder result is obtained although the sound quality may not be as good as in the "Bell" telephone.

Because a battery provides the power, for longer distances a battery having a higher voltage is all that is required. This will send more current through the circuit. Carbon microphones were used in telephones until the development of the modern push-button type and many are sill in use today.

Children can have a lot of fun using the home-made telephone but it must be impressed on them that this is a completely different device compared with the "string telephone" or "speaking tube" experiments described last month. In these, the sound itself travelled along the string or in the air contained in the tube. In the present experiment, *energy conversions* took place – sound to electricity and electricity back to sound. The advantage of doing this is to produce a greater range. Also, the signals can turn corners, etc. You can tie a knot in the wire to show that the electrical signal can still get through!

TELEPHONE EXCHANGE EXPERIMENT

Early telephones were used for private point-to-point communication. Queen Victoria had such a telephone line installed for her personal use. It quickly became apparent that by connecting such private lines together people could talk to one another as they wished. Thus, the first telephone exchange was invented. This was set up in Newhaven, Connecticut in 1878. Soon afterwards, telephone exchanges appeared in all other important centres.

It is fun to show this principle by making and operating a simple telephone exchange using the "Bell" telephone. You will need the following items:

1 piece of wood 30 cm square and 15mm thick
10 off 25 mm panel pins
100m of light-duty twin wire (bell wire)
5 off miniature loudspeakers
4 off 6V 0.06A lamps and lampholders
4 off PP3 batteries and connectors
4 off bell pushes
4 sections of 3A screw terminal block
8 off pieces of stranded wire 30cm in length fitted with a small crocodile clip at each end
4 off self-adhesive plastic feet

Hammer the panel pins into the wood as shown in Fig. 6 until the heads are left 12mm above the face of the wood. Attach the plastic feet to the underside. Attach the four lamp holders in the positions shown using small woodscrews. Cut off suitable lengths of twin wire for the remote stations and connect the ends to the panel pins as shown. This is done be removing the end 10mm of insulation and twisting it around the panel pins tightly.

Connect the loudspeakers and the lamp holders. Connect the bell pushes and battery connectors to the distant ends of the wires using the pieces of terminal block as shown. The lamps and batteries will be used by one "subscriber" to call the "operator" and "book" a call to one of the others. Readers with sufficient electrical

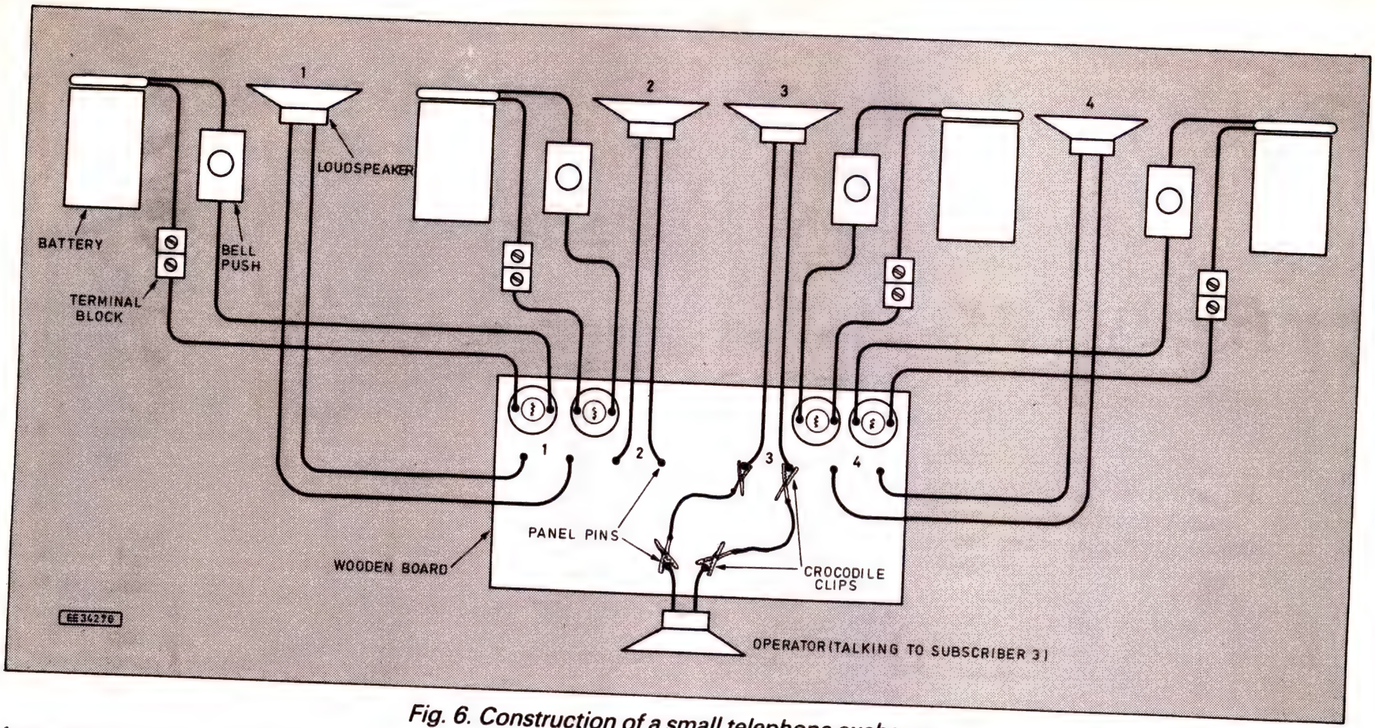


Fig. 6. Construction of a small telephone exchange.

knowledge could simplify the circuit by using a common wire for the lamps and loudspeaker circuits but it may then be difficult for children to follow (although in many cases this will not matter anyway).

EXCHANGE OPERATION

The "operator" sits in one room with the "exchange" and the four "subscribers" sit in other places were they cannot hear one another directly. Each subscriber is given a number 1 to 4. When one person wants to speak to another they first of all flash their lamp to the operator. On receiving this signal, the operator connects his or her loudspeaker to those of the subscriber wishing to make the call using the short wires with crocodile clips on the ends. The operator can then talk to the subscriber and find out which number is wanted.

The operator then disconnects his or her own loudspeaker and connects together the wires of the two subscribers wishing to talk in the same way. The whole activity soon turns into utter chaos with everyone wanting to talk to other people and no one wanting to listen – it is fun, though!

In the early 20th century, telephone exchanges operated on a similar principle to this model but on a much larger scale. Rows of operators were needed to connect together the wires of many hundreds of subscribers wishing to make calls. They used pieces of wire with a "jack plug" on each end to make the connections. Today the switching of the lines is done with totally automatic telephone exchanges.

The story behind the automatic telephone exchange is interesting. It was invented by an American called Almon B. Strowger – a man of argumentative disposition. He had frequent quarrels with telephone operators which led him to invent the automatic telephone exchange. Strowger exchanges used mechanical switches to connect the lines together – many exchanges of this type are still in use throughout the world today. However, the latest automatic exchanges are *electronic* and have no moving parts. These are smaller, silent in operation and extremely reliable.

RADIO COMMUNICATION

Although the telegraph and the telephone were great advances in the history of long-range communication, it had long been the dream of man to send messages without wires – that is, *wireless* communication. This would be much more versatile – it could be used to communicate with ships at sea, for example.

James Clerk Maxwell (1831-79) showed mathematically that "radio waves" should exist. However, Maxwell died before Heinrich Hertz in 1887 actually succeeded in producing them and sending a signal from one part of his laboratory to another. It was a rather primitive experiment but showed the way forward.

Hertz produced radio waves by means of *electric sparks* (we know that the radio crackles when there is a flash of lightning). When the waves were received by a further piece of apparatus, sparks were produced there also – thus, a signal had been sent over a short distance without connecting wires.

In 1894 the Italian, Guglielmo Marconi, used such a spark transmitter in conjunction with a Morse key to send short-range messages (see photograph). This turned out to be an historic event and on it rested the development of all modern radio communication including television.

Marconi gradually improved his apparatus and increased the range of communication – soon messages were being transmitted across the English Channel and to ships at sea. In 1901, he succeeded in sending a signal across the Atlantic Ocean from Cornwall to Newfoundland – a distance of over 3000km. The telegraph companies were not pleased because wireless communication threatened their business and they tried to discredit Marconi.

In 1906, the triode valve was invented by the American engineer, Lee de Forest and this led to the production of far more sophisticated transmitters which did not

Marconi with his transmitter and receiver.

rely on using sparks. For his work in the field of wireless communication, Marconi was awarded the 1909 Nobel prize for physics.

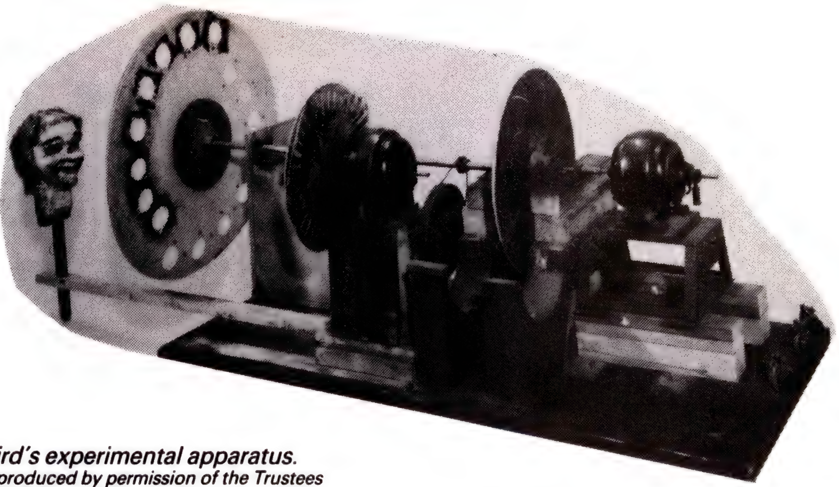
WIRELESS TELEPHONY

Soon it was possible to send the human voice by radio – Wireless Telephony was born. In 1922 broadcasting from London was begun from a station with the famous call sign 2LO and later in the same year this became the British Broadcasting Corporation. People received the programmes using a simple type of radio receiver called a "crystal set". This needed no batteries – the signal received by the aerial providing the power. Unfortunately, the sound was so weak that only headphone reception was possible.

The use of triode valves enabled more powerful and sensitive radios to be made (see photograph of the 1920's receiver). These were capable of operating a horn loudspeaker so that a number of people could listen to the broadcast at the same time. For these radios, a power supply was needed. Battery-powered portable sets were soon produced and even car radios using valves. However, wonderful as they were, valves were large, fragile, unreliable and power-hungry.

The successor to the valve, the transistor, was invented by the team or physicists, Bardeen, Brattain and Shockley. This was demonstrated in 1948. The transistor is much smaller, more reliable, more robust and needs much less power than a valve. Thus, a whole new generation of electronic devices became possible. Smaller and much more reliable battery-operated – even pocket-sized radios – were made.

The invention of the transistor was a major landmark in history and marked the beginning of electronic technology as we know it today.



Baird's experimental apparatus.
(Reproduced by permission of the Trustees of the Science Museum).

CRYSTAL SET EXPERIMENT

The simple radio described here is a modern version of the original crystal set. early listeners used a small piece of "crystal" – this was a piece of galena (lead ore) which was touched with a "cat's whisker" – a thin piece of wire. Today a germanium diode may be used to replace the crystal and cat's whisker, also a modern crystal earpiece replaces the clumsy headphones used long ago. Note that a pair of modern stereo headphones *will not work* in this circuit.

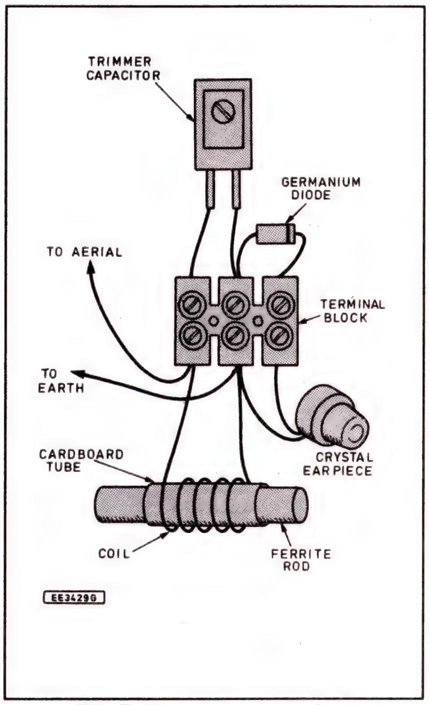
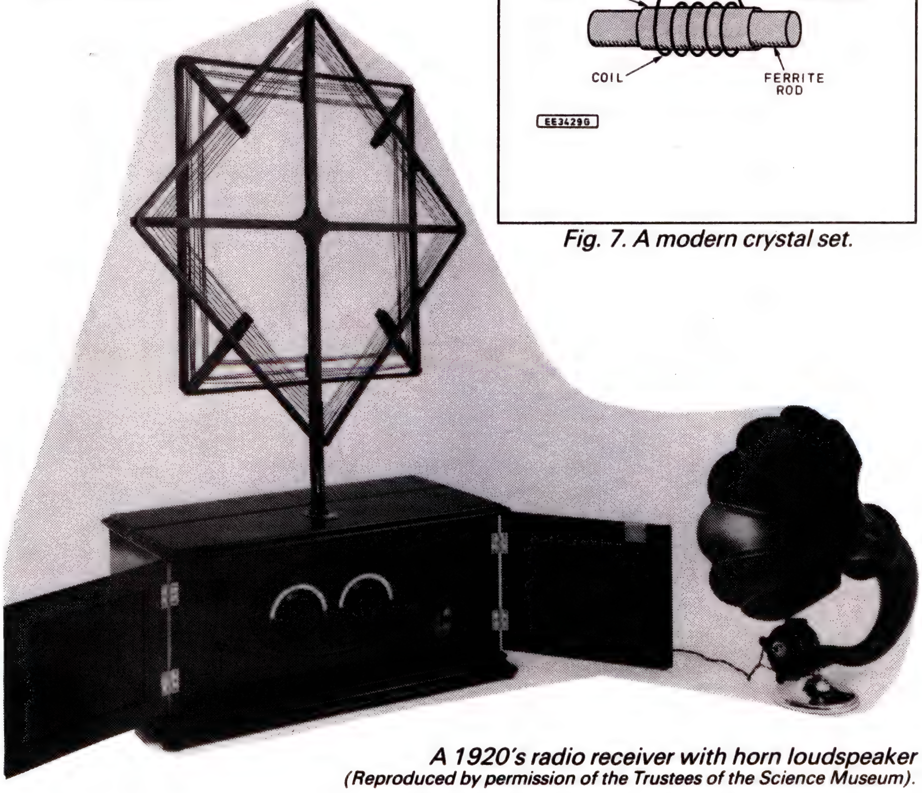


Fig. 7. A modern crystal set.



A 1920's radio receiver with horn loudspeaker
(Reproduced by permission of the Trustees of the Science Museum).

The crystal set will only give good results if you are fairly near a powerful transmitter and a long aerial is used.

You will need the following components:

A ferrite rod 8 or 10mm in diameter and 100mm long approx
Sufficient 24 s.w.g. enamelled copper wire (or thin plastic insulated wire) to wind at least 50 turns on the ferrite rod
Crystal (not magnetic) earpiece
20m of plastic insulated wire (for the aerial and earth)
OA90 or OA91 germanium diode
500pF trimmer capacitor
3 pieces of 3A screw terminal block to make all the connections

Begin by making a thin cardboard sleeve about 5cm long which will slide along the ferrite rod. Sellotape it into shape. With the sleeve in position on the ferrite rod, wind approximately 50 turns of wire onto it. Wind only one layer with successive turns touching. Keep the wire fairly tight but not so tight that the paper sleeve cannot slide freely. Leave 10cm of wire free at each end and Sellotape the coil to the sleeve. Now gently scrape the enamel insulation (or remove the plastic) from the end 10mm of each end of the wire.

Arrange the components on the terminal block as shown in Fig. 7 The aerial should be set up outdoors as long and as high as possible. If it is clear of buildings it will work better. Connect a short length of wire to "earth" – this could be connected to a water tap or to a metal rod which is then pushed as far as possible into the ground outside.

Use a small screwdriver to set the screw on the trimmer to approximately mid-position. Listen to the earpiece and "tune" the radio by adjusting the position of the ferrite rod in the coil. Tuning may also be carried out by adjusting the trimmer capacitor. If you are lucky you will hear some radio broadcasts.

Experiment with a different number of

Baird's first commercial receiver.
(Reproduced by permission of the Trustees of the Science Museum).

Marconiphone TV of 1936.
(Reproduced by permission of the Trustees of the Science Museum).

turns of wire on the coil – more turns (around 150-200 turns) will give long wave reception (Radio 4 on 198kHz) and fewer turns, perhaps, 10 to 20 for short waves.

TELEVISION

The spoken word has power but pictures and words have even more impact. With speech and music carried by "wireless", people wondered if it would be possible to send pictures too. In the days of the electric telegraph, methods had been developed to send still pictures (phototelegraphy) but only at slow speed. Sending "live" pictures was a problem. It was clear that pictures could not be sent in their entirety. It would be necessary to split them into parts and to send these in turn very quickly. When re-assembled, it would appear that the complete picture was being seen.

Some form of scanner was needed to divide the picture up then the information of each piece of the picture would be sent by radio waves. The first successful method was demonstrated by John Logie Baird (1888-1946), the son of a Scottish minister. He used a mechanical scanner in a rough and ready arrangement of everyday articles which he bought for practically nothing (see photograph).

Initially the results were very poor but in 1925 he succeeded in sending moving pictures. He even televised colour pictures in 1928. Unfortunately, because Baird used mechanical equipment, it suffered from many problems. His system was used for a short time for commercial broadcasting and receivers were available at the time (see photograph).

In 1928, an electronic system of scanning was invented by the Marconi Company working with EMI. This gave far higher quality pictures than the Baird system and television as we know it was born. The first regular TV service was broadcasted from Alexandra Palace, London, in 1936. The second World War stopped these activities but they re-commenced in 1946 when hostilities were over.

Colour television broadcasting began in America but not in Britain until 1967. Today, teletext information is carried by the radio waves along with the sound and picture. We may now receive almost instantaneous broadcasts from all over the world using satellites. More will be said about this in a later part of the series.

Recording live pictures was a further important advance. Video recorders were being used in the USA for recording television broadcasts as long ago as 1958. Before this, live action had to be recorded on film. Video recording is another example of *information storage* and will be looked at in more detail next month. Today, we use videocassette recorders in our own homes so that we can watch our favourite programmes at times which suit us.

ELECTRONICS TEACH-IN No5

Guide to Building Electronic Projects
Price £2.95

Due to the demand from students, teachers and hobbyists we have put together a range of articles from past issues of *Everyday Electronics* that will assist those getting involved with the construction of electronic projects for the first time.

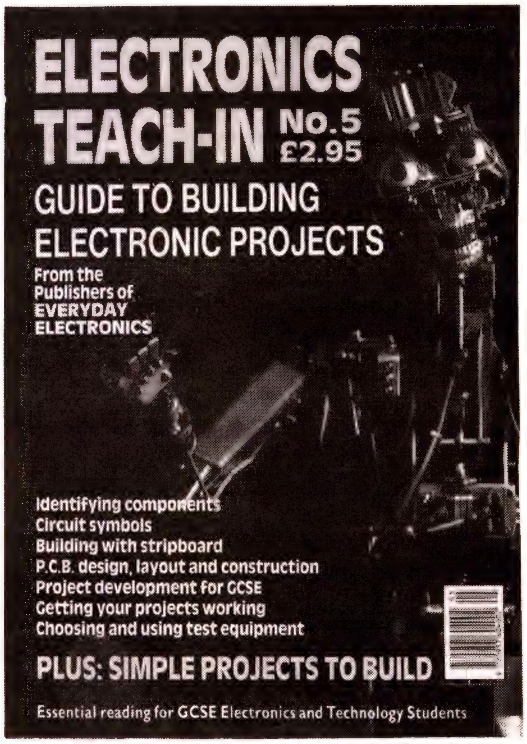
The book contains the complete *Project Development for GCSE* series.

Features
First Steps in Project Building
Building with Stripboard
Getting Your Projects Working
Choosing and Using Test Equipment
Printed Circuit Board Design, Layout & Construction
Project Development for GCSE

Data
Component Codes
Component Identification and Polarity
Circuit Symbols

Projects
Digital Experimenters Unit
Low Cost Capacitance Meter
Personal Radio
Quizmaster
Lie Detector

An invaluable resource for those teaching and studying GCSE Electronics or Technology courses



ELECTRONICS
TEACH-IN No.5 £2.95
GUIDE TO BUILDING
ELECTRONIC PROJECTS
From the Publishers of EVERYDAY ELECTRONICS

Identifying components
Circuit symbols
Building with stripboard
P.C.B. design, layout and construction
Project development for GCSE
Getting your projects working
Choosing and using test equipment

PLUS: SIMPLE PROJECTS TO BUILD

Essential reading for GCSE Electronics and Technology Students

See Direct Book Service pages for ordering details

REPORTING AMATEUR RADIO

Tony Smith G4FAI

HAM RADIO AND THE COUP

An intriguing story in the *W5YI Report* reveals that an amateur radio station, R3A, inside the Russian "White House" parliament building, was used by Boris Yeltsin during the recent events in Moscow.

Both CNN and ABC television showed Mr Yeltsin transmitting on the Icom amateur equipment, while the *Wall Street Journal* reported "Mr Yeltsin's efforts to rally support are still being hampered by a lack of communications with the nation. So far his aides have been broadcasting news to ham radio operators on a makeshift short wave transmitter installed on the sixth floor of the Russian parliament."

When it was all over, Dick Ehrhorn, W4ETO, received a handwritten Fax from a radio amateur in Moscow. "Dear Dick, I send you the Fax from the Russian Prime Minister office. We win! Mr Gorbachov back in Moscow. Our special emergency station R3A still operates from "Russian White House". Equipment: IC-726 (transceiver) and Alpha 76 (amplifier). Photos will be! 73! Gene, RA3AA."

Gene is a friend and business associate of Dick who owns Ehrhorn Technological Operations Inc., makers of the Alpha line of amplifiers, one of which was used by the Russian station. In talking to the *W5YI Report*, Dick commented "The average Soviet salary is around 200 to 300 rubles a month . . . which is around ten dollars. . . . No one can afford to buy commercial ham gear. The Alpha amplifier they have came from a flea market in western Europe."

LAUNCH CONFIRMED

I mentioned last month that AMSAT, the Radio Amateur Satellite Corporation, was planning a new super enhanced satellite to be known as phase III D. The European Space Agency has now confirmed an October 1995 launch slot for the doughnut shaped, 1,200-pound, 10-feet wide satellite which will have an orbital period of 16 hours. This will make it consecutively accessible over Europe, USA and the Far East.

Colour imaging, educational broadcasting and other experiments are planned. There are currently twelve *OSCAR* satellites in orbit. The most recent, *OSCAR-22*, was launched last July. *(W5YI Report).*

NICAD CARE

Icom are advising all users of their equipment containing NiCad battery packs to fully "cycle" the pack a number of times when the equipment is first purchased. Five or six *full* charge and discharge cycles, they say, will extend the time between charges and allow the packs to achieve their full potential.

While NiCads can be extremely good in terms of cost-economy, they are not necessarily the answer to every battery need. Fully charged, they have a typical voltage of 1.2V dropping to 1.0V when exhausted, compared to 1.5 to 0.8V in primary cells which they can usually replace, cell for cell in equivalent sizes.

However, when a high voltage level is required in equipment designed for use with NiCads, such as a transmitter, extra cells are installed to provide the necessary total voltage. Instead of eight primary cells (x 1.5V nom.) providing a 12V supply, for instance, ten NiCads (x 1.2V) are used.

The fact that they hold their full voltage almost to the end of their charge means that it is not always possible to anticipate battery exhaustion. In amateur radio this situation usually occurs when operating in the middle of a field miles from anywhere, just when contact has been made with a rare "Dx" station! Where equipment needs to be kept running, therefore, a spare set of fully charged NiCads is needed for immediate replacement purposes.

Care should always be taken to avoid shorting NiCads. They have a low internal resistance and high current will flow causing damage to the cell. They are not suitable for use in very low power equipment, such as electric clocks, where primary cells are normally replaced about once a year, as they normally self-discharge to exhaustion in about half that time. When not in use at all they will also discharge themselves but this does not affect their capability for recharge.

RECHARGING

Makers recommend using a NiCad until it is discharged, and then recharging it for a specified period at a current appropriate for the particular size cell. Care should be taken in cold weather when low temperatures can cause increased internal pressure of a cell with possible harmful results.

Cells can be recharged before they are fully discharged with the time period correspondingly reduced. In this case some estimate of use should be made, adding about 20 per cent to the estimated expired capacity. But if this is done frequently the practice carries the risk of overcharging and reducing the potential life of the cells.

They may also acquire a "memory" for the reduced charge/discharge cycle, resulting in an inability to take the full charge. Advertisements for NiCads sometimes claim that they will not be harmed if they are charged for longer than the recommended periods. This is true in the short term.

The charging rates recommended are such that cells may safely receive overcharge for indefinite periods, but frequent excessive charging can reduce their overall life due to heating effects. Because of its construction, the PP3 equivalent size NiCad is particularly vulnerable in this connection.

In radio receivers NiCads are fine if the receiver is used frequently. If it is used infrequently the user will be disappointed at the apparent shortness of life following each charge. In use, the cells should be exhausted to the point where the receiver no longer functions satisfactorily and they should then be recharged at normal room temperature.

There are various approaches if you take these and other (not mentioned) precautions seriously. For example, I use a timer/cut-out to restrict the charging time to the recommended period.

An article in an American magazine recently described a unit which discharges cells automatically down to 0·75V to ensure satisfactory discharge before recharging, while preventing accelerated discharge to zero volts and possible "cell reversal". A German magazine featured a charger which samples the voltage across the NiCads under charge every eight minutes; if the new sample is lower than the previous sample full charging has been achieved and the charger is automatically switched off.

Although there are so many aspects to consider to obtain optimum performance from NiCads I doubt if many users bother much about them. After all, if you get only half the number of recharges claimed, it still represents a good saving over buying new batteries every time the old ones run out! The ideal, of course, would be a rechargeable cell giving the full performance claimed by the manufacturers without any of the reservations or provisos associated with NiCads.

SANGEAN SERVICING

I have received a letter from a reader whose Sangean ATS 803A world band receiver has broken down out of guarantee. He has been told by the original suppliers, Comet, that they are unable to obtain spares and cannot repair it for him. If any readers know somewhere he might get it serviced please let me know via the editor.

It will be disappointing if the ATS 803A is now obsolete. The 1991 issue of "Passport to World Band Radio" reviews it as "the best world band radio for under $400 (USA)". However, even the best models become "discontinued" and I'm currently trying to confirm the position with Comet.

In the meantime, if anyone can provide information about the current status of this receiver please let me know. The same set has been sold under their own brand names by Currys, Tandy and Dixons and presumably the supply position is the same with them all?

HART AUDIO KITS – YOUR VALUE FOR MONEY ROUTE TO ULTIMATE HI-FI

HART AUDIO KITS give you the opportunity to build the very best engineered hifi equipment there is, designed by the leaders in their field, using the best components that are available.

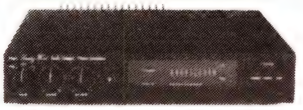
Every HART KIT is not just a new equipment acquisition but a valuable investment in knowledge, giving you guided hands-on experience of modern electronic techniques.

In short HART is your 'friend in the trade' giving you, as a knowledgeable constructor, access to better equipment at lower prices than the man in the street.

You can buy the reprints and construction manual for any kit to see how easy it is to build your own equipment the HART way. The FULL cost can be credited against your subsequent kit purchase.

Our list will give you fuller details of all our Audio Kits, components and special offers.

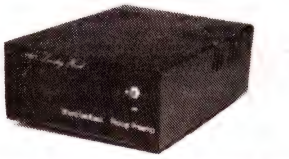
AUDIO DESIGN 80 WATT POWER AMPLIFIER.



This fantastic John Linsley Hood designed amplifier is the flagship of our range, and the ideal powerhouse for your ultimate hifi system. This kit is your way to get £K performance for a few tenths of the cost!. Featured on the front cover of 'Electronics Today International' this complete stereo power amplifier offers World Class performance allied to the famous HART quality and ease of construction. John Linsley Hood's comments on seeing a complete unit were enthusiastic:- The external view is that of a thoroughly professional piece of audio gear, neat elegant and functional. This impression is greatly reinforced by the internal appearance, which is redolent of quality, both in components and in layout. Options include a stereo LED power meter and a versatile passive front end giving switched inputs using ALPS precision, low-noise volume and balance controls. A new relay switched front end option also gives a tape input and output facility so that for use with tuners, tape and CD players, or indeed any other 'flat' inputs the power amplifier may be used on its own, without the need for any external signal handling stages. 'Slave' and 'monobloc' versions without the passive input stage and power meter are also available. All versions fit within our standard 420 x 260 x 75mm case to match our 400 Series Tuner range. ALL six power supply rails are fully stabilised, and the complete power supply, using a toroidal transformer, is contained within a heavy gauge aluminium chassis/heatsink fitted with IEC mains input and output sockets. All the circuitry is on professional grade printed circuit boards with roller tinned finish and green solder resist on the component ident side, the power amplifiers feature an advanced double sided layout for maximum performance. All wiring in this kit is pre- terminated, ready for instant use!.

RLH11 Reprints of latest articles	£1.80
K1100CM HART Construction Manual	£4.50

LINSLEY HOOD 'SHUNT FEEDBACK' R.I.A.A. MOVING COIL & MOVING MAGNET PICKUP PREAMPLIFIER

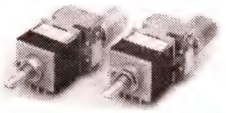


Modern, ultimate sound systems are evolving towards a built-in RIAA preamplifier within the turntable unit, keeping noise pickup to a minimum. This new circuit by John Linsley Hood uses latest generation integrated circuits in the sonically preferred shunt feedback configuration to give an accurate and musical sound, with the ability to use both moving magnet and moving coil cartridges. Power comes from two 9v PP3 size batteries or a mains power supply. This HART kit is exceptionally easy to build with detailed instructions and all the specially selected components fitting directly on to the roller tinned fibreglass printed circuit board. Even the gold plated phono sockets mount directly on the board.

This Kit now comes with latest generation low-noise front end IC and onboard power stabilisers for any DC input voltage between 9v and 30v.

K1500 Special Discount Price for complete Kit	£67.99

ALPS PRECISION LOW-NOISE STEREO POTS.



To fulfil the need for higher quality controls we are now importing an exciting new range of precision audio pots in values to cover most quality amplifier applications. All in 2-gang stereo format, with 20mm long 6mm dia. steel shafts. Now you can throw out those noisy ill-matched carbon pots and replace with the real hi-fi components only used selectively in the very top flight of World class amplifiers. The improvement in track accuracy and matching really is incredible giving better tonal balance between channels and rock solid image stability. Motorised versions have 5v DC Drive motor.

2-Gang 100K Lin	£8.86
2-Gang 10K, 50K & 100K Log	
£9.60 2-Gang 10K Special Balance	£10.71
2-Gang 20K Log MOTORISED	£19.20
2-Gang 10K Special Balance, MOTORISED, zero crosstalk and < 10% centre loss with near Log/Antilog Tracks)	£19.98

HIGH QUALITY REPLACEMENT CASSETTE HEADS

Do you tapes lack treble?. A worn head could be the problem. For top performance cassette recorder heads should be replaced every 1,500 hours. Fitting one of our high quality replacement heads could restore performance to better than new!. Standard inductances and mountings make fitting easy on nearly all machines (Sony are special, see below) and our TC1 Test Cassette helps you set the azimuth spot on. As we are the actual importers you get prime parts at lower prices, compare our prices with other suppliers and see!. All our heads are suitable for use with any Dolby system and are normally available ex stock. We also stock a wide range of special heads for home construction and industrial users.

HM120 Standard Mono R/P Head	£3.51
HC15 Standard Quality Stereo R/P Head	£2.49
HC66 High Quality Stereo R/P Head. Permalloy	£7.98
HS16 Sendust Alloy Stereo Head	£16.85
HC80 NEW RANGE High Beta Permalloy Stereo head. Modern space saver design for easy fitting and lower cost. Suitable for chrome metal and ferric tapes, truly a universal replacement head for everything from hi-fi decks to car players and at an incredible price too!	£8.30
HQ551 4-Track RECORD & Play Permalloy Head for auto-reverse car players or quadraphonic recording	£14.90
H524 Standard Erase Head	£1.90
H561 Hi Field Erase Head for METAL Tapes	£3.49
HRP373 Downstream Monitor Stereo Combination Head	£47.90

Many other SPECIAL cassette Heads in stock, see our LIST.

REEL TO REEL HEADS

999R 2/4 Record/Play 110mH. Suits Stuart Tape Circuits	£13.64
998E 2/4 Erase Head 1mH. Universal Mount. Suits Stuart	£11.98

TAPE RECORDER CARE PRODUCTS

HART TC1 TEST CASSETTE Our famous triple purpose test cassette. Sets tape azimuth, VU level and tape speed	£5.36
DEM1 Mains Powered Tape Head Demagnetizer, prevents noise on playback due to residual head magnetisation	£4.48
DEM115 Electronic, Cassette Type, demagnetizer	£8.91

COMPUTER CORNER

This month we are pleased to introduce a new range of VERY competitively priced, High Quality, computer systems. Due to our long experience of importing we have the necessary contacts in the Far East to buy at very advantageous prices and can pass the savings on to you.

HART MODEL AT-286/16WP WORDPROCESSOR/COMPUTER SPECIAL

The Fastest wordprocessor in the west! Only a few years ago the AT-286 machine was the fastest standard office computer known. Now we can offer the superfast 16MHz version. (earlier ones were only 10 or 12MHz) at such an incredibly low price that it can be used in any office or home. Not only that but ours comes with ultrafast memory so that the machine can run in 'zero wait state'.

Advanced features are:– Full 1MB of memory (Expandable to 4MB), 102 key UK keyboard, compact desktop case, 1.44MB 3.5" Disk Drive and interface card for extra drive, Graphics/Printer Card, built in Hard Disk Interface.

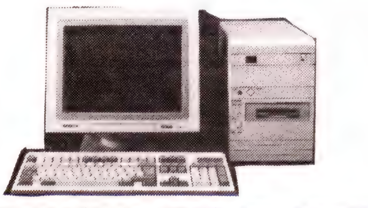
HART AT-286/16WP	ONLY £277.25 (Ex Vat)
14" FST (Flatter Squarer Tube) Hercules monitor, Amber	£83
14" Paper White Hercules Monitor. (Both have T/S Base)	£86
40MB AT-286/16UG Hard Disk Computer	£523.50 (Ex Vat)

Specification as above but with SIMM memory, 45MB 25ms hard disk, VGA Colour Graphics Card with 512K RAM, upgradeable to 1MB, parallel printer port, 2 serial ports, 1 game port. 14" VGA Mono Monitor, Amber £86.70 Paper White £89

HART 40MB AT-386/16SX EL

Entry level 386 machine for demanding applications at moderate cost. Spec as above but 1MB Dram memory, Mini Tower case, 45MB 25ms hard disk drive, VGA Colour Graphics Card with 256K RAM, 40MB AT-386/16SX EL is ONLY £634.30 (Ex Vat)

HART 52MB AT-386/20SX UG



Luxury version of the above with higher processor speed and amazing 9 millisecond access time hard disk. 2MB SIMM RAM, Compact Tower Case, VGA 1024 x 768 card with 512K RAM, upgradeable to 1MB of Video memory. 40MB AT-386/20SX UG..........ONLY £853.10 (Ex Vat)

OPTIONAL EXTRAS

HART Computers can be 'custom made' to fit your personal requirements, at NO extra cost!. Simply select the options you require. If replacing any item in the standard specification for that model then deduct the cost of the part not needed.

SOFTWARE

MS-DOS 5 Latest Release. Complete with Manual. 3.5" Disks	£59
Microsoft Windows 3. 3.5" Disks	£65

MONITORS

SM1421 AM TU Hercules Mono with FST Tube and Stand, Amber	£83
SM1421 PW TU As Above but Paper White Screen	£86
SM1416 A VGA Mono Monitor c/w tilt and swivel stand. Amber	£86.70
SM1416 W As Above, Paper white	£89
SM1485-00 Super VGA Multisync Colour Monitor, ·28" dot pitch, 50MHz Bandwidth, up to 1024 x 768, c/w stand	£235

KEYBOARDS

K261 102 Key Enhanced UK Layout, Tactile Click, AT/XT Switchable with dual slope feet.(Standard Keyboard supplied with systems)	£31
K108 Similar to above, single slope feet, Alps switches	£36
KB6153A As above but with heavy metal base	£44

I/O and GRAPHIC CARDS

AT I/O Card 2 Serial, 1 Parallel, 1 Game Ports	£9.90
Hercules Mono Graphic & Printer card. £1.70 16-Bit VGA Card, 256K	£46.50
Trident 8900 VGA Card, fitted 512K, upgradeable to 1MB	£67.30
Extra 512K RAM for Graphics Card to bring it to 1MB	Add £9.60
Trident 8900 VGA Card with 1Mb fitted	£86.90

DISK DRIVES

5.25" 1.2Mb Floppy Disk Drive	£49
3." 1.44Mb Floppy Disk Drive	£45
Adapter to fit 3.5" drive in 5.25" slot, c/w power adapter	£9
45MB 25ms Hard Disk Drive	£165
52MB Quantum Hard Disk. Lightning Fast 9ms Access time	£261

CASES

WE 611P Desktop Case, Flip Top, 200W PSU	£56.40
WE727P Mini Tower Case, 200W PSU	£84.70
108MP Mini Tower Case, Compact Style	£89
CT107 Midi Tower Case	£108

MOTHERBOARDS

AT-286/16 0K.RAM	£89
AT-386-16SX 0K.RAM	£195
AT-386-20SX 0K.RAM	£245

PLEASE NOTE THAT ALL ITEMS IN THIS SECTION ARE PRICED EX VAT.

Send or 'phone for your copy of our List (50p) of these and many other Kits & Components. Enquiries from Overseas customers are equally welcome, but PLEASE send 2 IRCs if you want a list sent surface post, or 5 for Airmail.

Ordering is easy. Just write, telephone or fax your requirements to sample the friendly and efficient HART service. Payment by cheque, cash or credit card. A telephoned or faxed order with your credit card number will get your order on its way to you THAT DAY.

Please add part cost of carriage and insurance as follows:–**INLAND Orders up to £20 - £1.50 Orders over £20 - £3.50 Express Courier, next working day. £10 (For safety all computer parts are only sent by courier) OVERSEAS – Please see the ordering information with our lists.**

MANUFACTURERS OF QUALITY AUDIO KITS AND COMPUTERS

24 hr. SALES LINE
(0691) 652894
Fax: (0691) 662864

AUDIO KIT PRICES are VAT INCLUSIVE. COMPUTER PRICES EXCLUDE VAT

HART ELECTRONIC KITS LTD
6 PENYLAN MILL
OSWESTRY, SHROPSHIRE
SY10 9AF

KNOCKERBOX

DAVID SMITH

Press the bell push and the door knocker bangs on the door. Its like a ghost standing beside you!

OVER the years, there have been many circuits published regarding electronic door bells, which generate sounds beyond the normal "ding-dong" type of chime. This has enabled the electronics constructor to possess a certain amount of individuality. Visiting family or friends could be greeted with a synthesized rendition of the *William Tell Overture, Star Wars* or *Beethovens 9th.*

There has even been an electronic device allowing the sound of a barking dog to be played, in the hope that it would ward off any potential burglar. The list seems endless, so you could be forgiven for thinking *"Oh no, not another electronic doorbell circuit".*

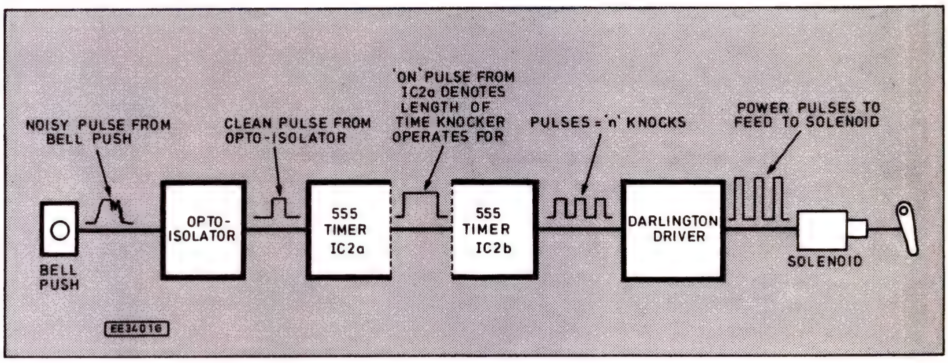
Well, it's hard to be different nowadays. Many people are no longer impressed when pushing door bells, only to be confronted with the usual melody chip, generating endless tunes through a tiny loudspeaker. What is needed is something entirely different to announce their arrival and the Knockerbox can fulfil that need.

What it offers, is a return to the "good old days". A time when there was no electronic noise pollution around. What the Knockerbox will provide (once a caller has pressed your bellpush), is a sharp "rat-a-tat-tat" on your door knocker! No, not an electronically generated sound as you might well expect, but the real thing!

HOW IT WORKS

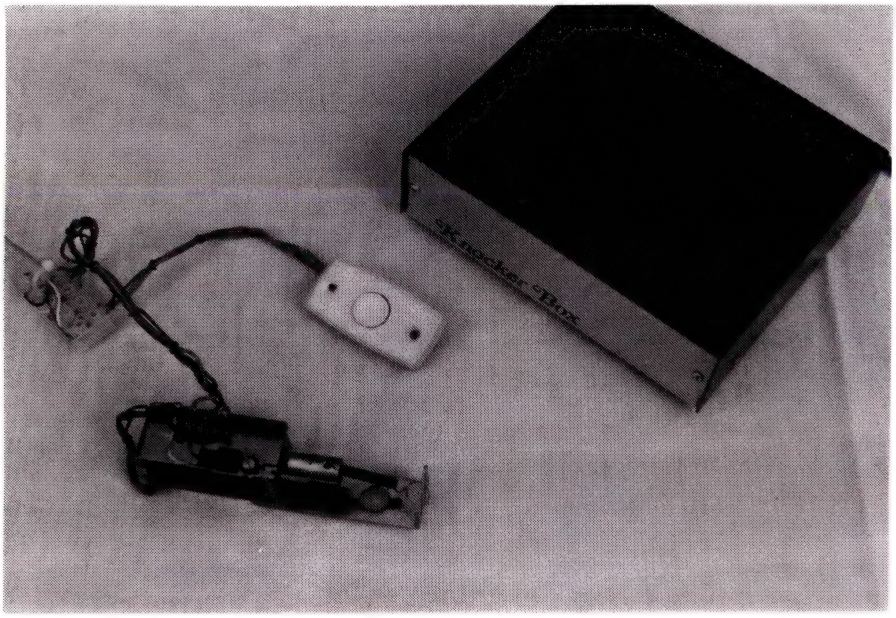
What we need from our circuit initially, is to detect when the bellpush has been pressed. We then need to process this information through an electronic circuit, to finally produce an electrical output capable of driving a solenoid connected mechanically to your front door knocker.

Referring to the block diagram in Fig. 1, we can see that the inherent noise emanating from the bellpush and its associated wiring, has to be cleaned up in some way. This is achieved by the use of an opto-isolator (IC1).



NOISY PULSE FROM BELL PUSH
CLEAN PULSE FROM OPTO-ISOLATOR
'ON' PULSE FROM IC2a DENOTES LENGTH OF TIME KNOCKER OPERATES FOR
PULSES = 'n' KNOCKS
POWER PULSES TO FEED TO SOLENOID
BELL PUSH
OPTO-ISOLATOR
555 TIMER IC2a
555 TIMER IC2b
DARLINGTON DRIVER
SOLENOID
EE34016

Fig. 1. Block diagram of the Knockerbox.



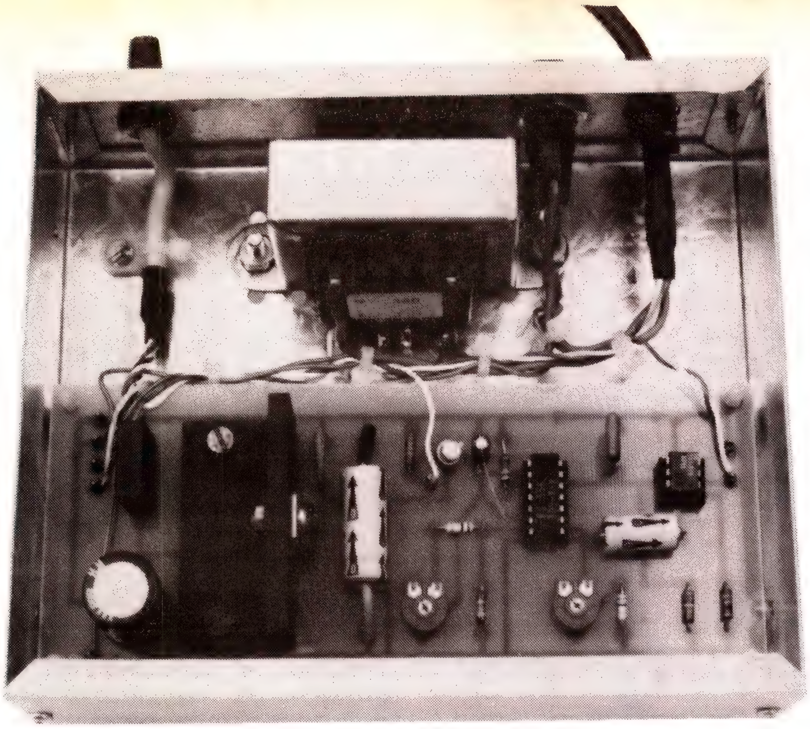
Once clean, this signal can be used to trigger the first of two 555 type timers, both housed in the same package. The first monostable timer provides us with an output pulse sufficiently long enough, to enable the second of our 555 timers (IC2b), to generate a short string of pulses.

These pulses are then fed to a Darlington driver pair of transistors, where the pulses are amplified sufficiently to drive a solenoid. It is this solenoid which operates the knocker on your front door.

CIRCUIT DESCRIPTION

The complete circuit diagram for the Knockerbox is shown in Fig. 2. Because the solenoid requires a fair amount of current to operate, it is impractical to run this circuit from dry batteries. The circuit has therefore been designed to run off ordinary domestic house mains.

If we look at Fig. 2, we can see that the power supply consists of a mains isolation transformer T1, a bridge rectifier D2 to D5 and a 12V stabiliser, IC3. Smoothing is accomplished by capacitors C4, C5 and C6.



The 12V regulator i.c. can supply up to 2A of current, to drive the solenoid. Of course the type of solenoid used, will depend very much on your own requirements i.e. size of door knocker fitted, the length of stroke that the solenoid has to travel, plus other mechanical considerations.

Resistor R1 provides voltage to the l.e.d. housed inside the opto-isolator IC1. Pressing the doorbell allows this l.e.d. to light up, thereby causing a transistor (also housed within the same chip) to conduct.

A suitable pulse therefore, is fed from the opto-isolators' output at pin 5, to the trigger input of IC2a, at pin 6. This action now provides an output pulse from IC2a at pin 5. The length of this output pulse is controlled by adjusting the setting of preset VR1 (used to determine the *length* of knock required).

Connecting IC2a's output (pin 5) to the trigger input pin of the second timer (IC2b, pin 10), initiates our second set of pulses at pin 9. These are the short repetitive pulses which will eventually form our "rat-a-tat-tat" sound, the speed of which is controlled by preset VR2 and its associated components resistors R4, R5 and capacitor C3.

Transistor TR1 receives these short pulses and passes them onto the solenoid driving transistor TR2, this being a TIP31A. Diode D1 offers protection against any back e.m.f., from the solenoid coil, which may cause damage to TR2.

CONSTRUCTION

A metal case should be used to house the project, as *safety* is of paramount importance. Three-core mains flex should be used in order to earth the circuits "ground rail", *plus* the metal casing of the enclosure.

Having selected a suitable metal case, drill two small holes in the base of the case to enable it to be fixed to the wall. Also at this stage, and before mounting components on the circuit board, you should use the board as a template to mark out the best positioning for the boards four corner fixing holes on the inside of the case bottom surface.

COMPONENTS

Resistors

R1	1k	R4	6k8
R2	12k	R5	100k
R3	10k	R6	150k
		R7	1k5

All 0.6W 1% metal film

See SHOP TALK Page

Potentiometers

VR1	100k horizontal skeleton preset, lin.
VR2	500k horizontal skeleton preset, lin.

Capacitors

C1	10n polyester layer
C2	47µ axial elec., 63V
C3	1µ radial elec., 100V
C4	0µ1 disc ceramic, 50V
C5	470µ axial elec., 25V
C6	680µ radial elec., 63V

Semiconductors

D1	1N4005 1A 600V rec. diode
TR1	BC108 *npn* transistor
TR2	TIP31A *npn* power transistor
IC1	2046 transistor opto-isolator
IC2	556 dual timer
IC3	78S12 +12V 2A voltage regulator
D2-D5	1·4A 60V bridge rectifier

Miscellaneous

T1	Mains transformer, 30VA 15V secondary
S1	Doorbell push switch
SOL	12V solenoid (see text)
FS1	0·5A fuse with chassis mounting fuseholder

Metal case, size 160mm x 140mm x 50mm; plastic box, to cover solenoid and TR2/D1; 8-pin d.i.l. socket; 14-pin d.i.l. socket; 8W heatsink for IC3; solder pins (8 off); connecting wire; solder. Leaf spring, wire, pulley etc. as required for door knocker.

Printed circuit board available from EE PCB Service, code EE775.

Approx cost guidance only **£27** plus cases

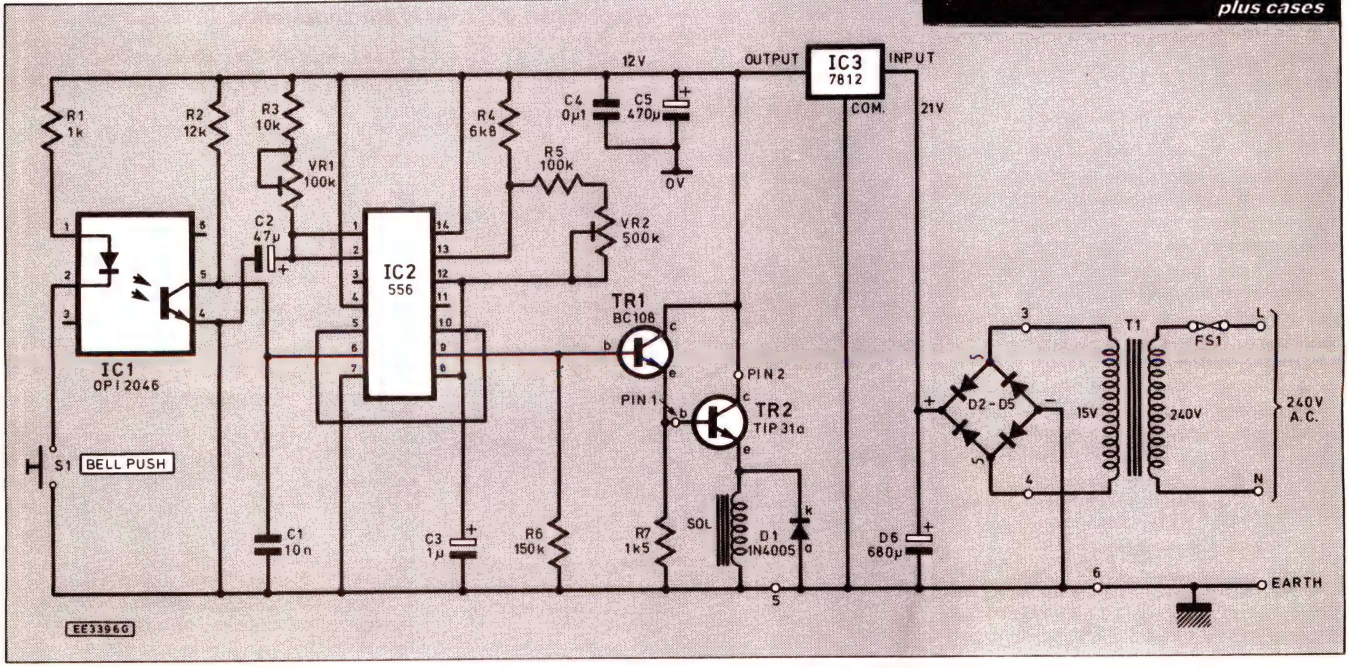


Fig. 2. Circuit diagram of the Knockerbox.

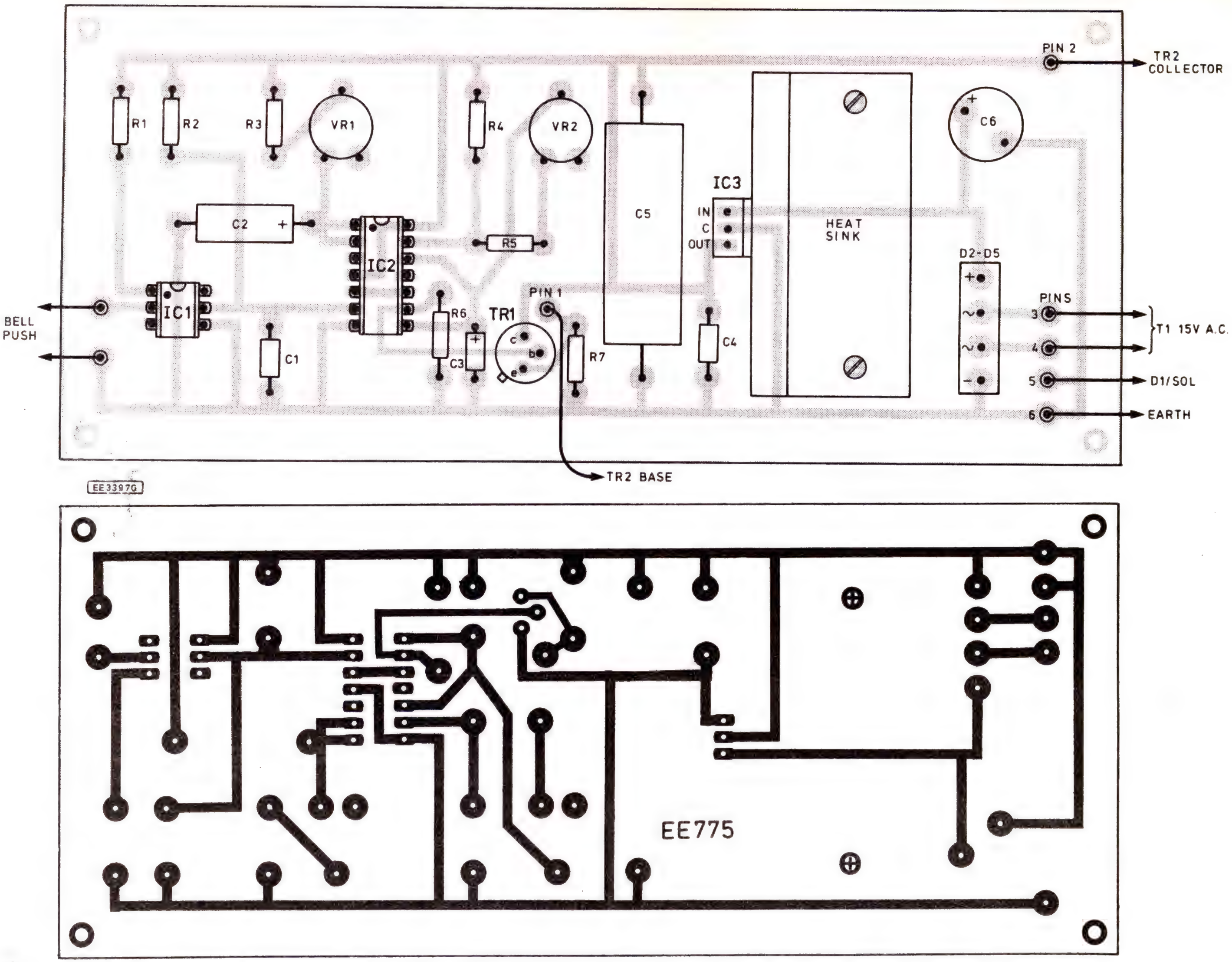


Fig. 3. Printed circuit board layout and wiring.

Once they have been marked you can decide whether to use self-adhesive stand-off pillars or drill through the case at the marks and use nuts (three per bolt) and bolts, preferably nylon, to secure the board in position later. The case should now be put to one side and attention turned to the printed circuit board.

The printed circuit board component layout and full size copper foil master pattern is shown in Fig. 3. This board is available from the *EE PCB Service*, code EE775.

Mount the components onto the printed circuit board as shown in Fig. 3. Before fixing the 12V regulator i.c. to the heat-sink, spread a little heat transfer compound between the two mating surfaces to improve thermal conductivity.

When fitting the transistors, diodes and electrolytic capacitors, check carefully their polarity. Also make sure that the i.c.s are correctly orientated.

Note that power transistor TR2 is not mounted on the p.c.b., but against the body of the solenoid, which in turn acts as a heatsink. Diode D1 is also connected directly to the transistor emitter lead, see Fig. 4. Both these components and the solenoid are mounted on the door.

Alternatively, TR2 and D1 could be mounted inside the case which houses the other components. The choice is yours, but do bear in mind that the TIP31A has a maximum current carrying capacity of 3A. Something to think about when choosing your solenoid.

WIRING

When all the components have been soldered into place, mount the board inside the case by way of the p.c.b.s four corner fixing holes. Referring to Fig. 5, mount the other components as shown, paying particular attention to the mains wiring.

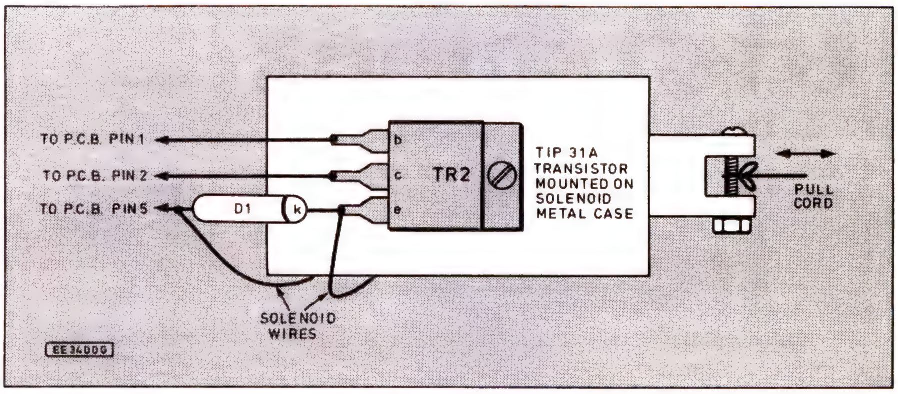
The "live" mains wire should be connected to the *rearmost* tag of the fuseholder FS1. Then, in the event of a fuse having to be replaced, the outer contact of the fuse holder, (easily touched by accident), will not be in contact with the mains!

Finally, the box, which *must* be fully enclosed, should be mounted near the front door. The mains lead should be run to the nearest 13A socket. Twin bell wire should be connected between the box and bellpush, and the wires used for the solenoid should be extra flexible and looped in such a way from the box to the door to incur minimum bending; see Fig. 6.

A smaller box can be fitted over the top of the door mounted solenoid to give it a neater appearance. This box also covers the power transistor TR2, so ample "air space" should be provided inside the box.

As the choice of solenoid is left to the individual's own requirements, the final "mechanical" arrangement of linking it to the door knocker may vary. However, the suggested method shown in Fig. 7 should prove to be the best approach for most set-ups.

Fig. 4. Mounting and wiring of TR2 and D1 on the solenoid.



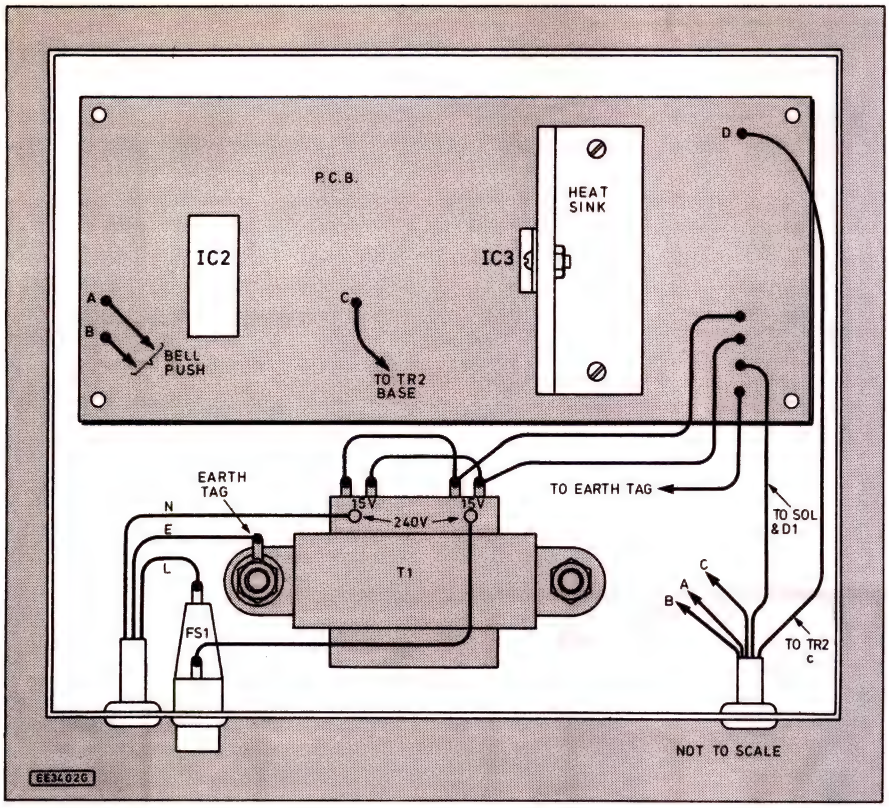


Fig. 5. Interwiring of the case mounted components and the p.c.b.

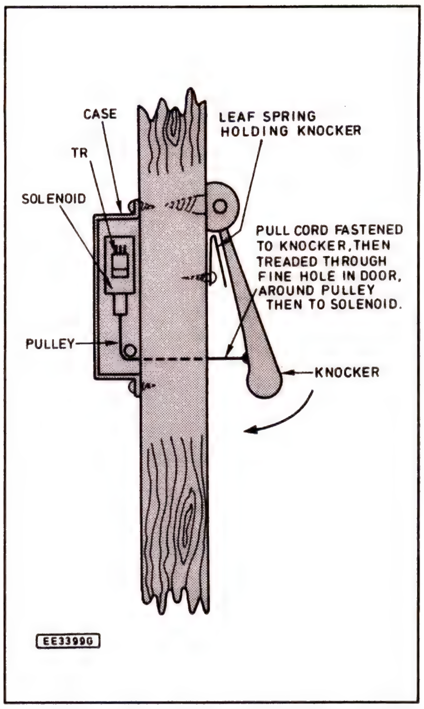

CASE
TR
SOLENOID
LEAF SPRING HOLDING KNOCKER
PULL CORD FASTENED TO KNOCKER, THEN TREADED THROUGH FINE HOLE IN DOOR, AROUND PULLEY THEN TO SOLENOID.
PULLEY
KNOCKER
EE3399G

Fig. 7. Fitting and operation of the solenoid/knocker.

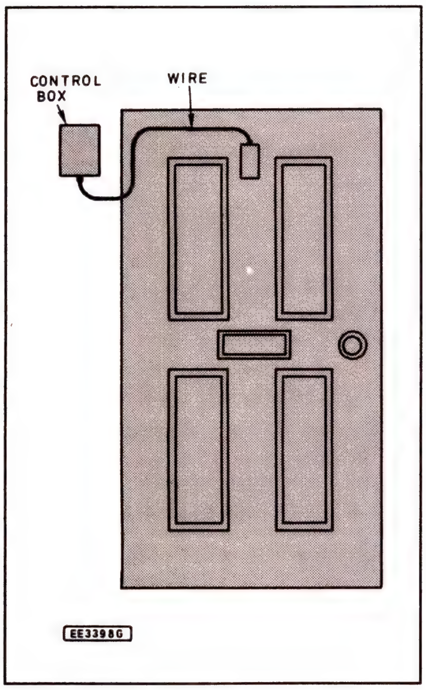


Fig. 6 (left). Fitting the unit to the door.

ADJUSTMENTS

As the following adjustments are best made with the circuitry connected to the front door solenoid and mains, it would be wise to make sure no one is likely to walk in through the door, and that toddlers and or pets are safely distanced.

Because of the presence of mains voltage extreme care must be exercised when carrying out adjustments.

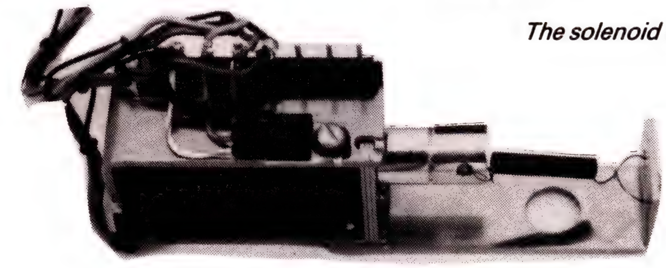
First set preset VR1 to its longest "on" period. This will enable the setting of preset VR2 to take place over a longer period.

Press the doorbell. The solenoid should start to pulsate; if it does not, this will be because pulses are being "fired" at it too quickly, thereby not giving it time to return to rest before the next pulse appears.

Turn VR2 slowly either way until the speed of "knocking" you desire has been achieved. You may have to repeatedly press the bellpush in order to re-trigger the circuit.

Once happy with the "knocking" *frequency*, reduce the setting of VR1 until the initial triggering pulse only allows the correct number of "knocks" to occur during one bell press. An average guide would be about six knocks over a period of two to three seconds. ☐

The solenoid with TR2 and D1.



EVERYDAY ELECTRONICS

SUBSCRIPTION ORDER FORM

Annual subscription rates (1991):
UK £18.50. Overseas £23 (surface mail)
£40.50 (airmail)

To: Everyday Electronics, 6 Church Street
Wimborne, Dorset BH21 1JH

Name..

Address...

....

I enclose payment of £ .... (cheque/PO in **£ sterling only** payable to Everyday Electronics)
Access or Visa No.

Signature.. Card Ex. Date ....

Please supply name and address of card-holder if different from the subscription address shown above. **Subscriptions can only start with the next available issue.** For back numbers see the Editorial page.

ROBOT ROUNDUP

Nigel Clark

MUSEUM OF AUTOMATA

One man's love of things mechanical has resulted in a new tourist attraction in York and the encouragement of an interest in robotics in a growing number of people. The *Museum of Automata* was opened in March last year in an old warehouse between Cliffords Tower and the River Ouse, in the ancient capital of the North of England.

In its first year (Mar.-to-Dec.) it attracted 50,500 visitors and this year as its fame has spread further afield the figures should show a 50 per cent increase. Up until the end of September, about 60,000 people had visited the museum. One major boost came at the *Robot Olympics* held last year at the Turing Institute in Glasgow when one of the exhibits, the Japanese Archer, took the Gold Medal in the Javelin class, beating many newer and apparently more sophisticated devices in the process.

The museum is the brainchild of a Surrey property developer, Jon Robertson, and his wife Andrea. His early childhood, spent on a farm, left him with a fascination for machines. Later he bought a singing bird box as an engagement present for his future wife and they were hooked.

Holidays would often include visits to antique shops and flea markets and the collection grew. They later were able to combine their collection with that of another enthusiast, Jack Donovan, when his collection was offered to them. Donovan used to run a hotel in Bournemouth where his automata helped to entertain the guests. He later dealt in automata with people from all over the world.

DISPLAY

Four years ago Jon and Andrea exhibited all their automata, which, despite being extremely fragile and needing skilled and careful handling and maintenance, were all in working order. From that came a suggestion that they be put on permanent display alongside more contemporary works, of which there are a growing number in Britain. Soon afterwards Robinson bought a disused warehouse in York and the idea began to blossom.

From the start the intention was to educate as well as to display. To this end the first thing visitors see is the video wall giving a five minute history of automata, beginning with the ancient Greeks who developed mechanical marvels such as singing birds and automatic washbasins based on their knowledge of gears, pneumatics and hydraulics and ending with specially-commissioned pieces.

This is followed by the displays of the actual devices. Unfortunately most of the older and more complex pieces are too delicate to be shown working but each display has a video showing how each piece works.

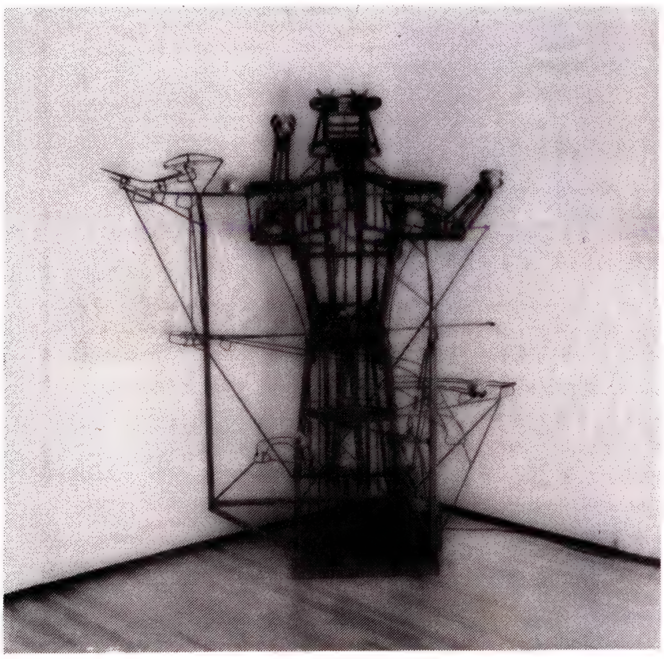
However many of the clocks, which include small automata as decoration or to chime the hours, are working. It is worthwhile being around on the hour to see many of them perform although there is also something to see on the quarters as well.

FRENCH CONNECTION

It is the French section showing models from the 19th century where the creations have been developed to such a degree that they meet one of the definitions of automata with no difficulty. That is that they be man-made objects which mimic the movements of living things, their mechanisms having their motive power so concealed that they appear to move spontaneously.

All the French models, which include smoking monkeys, musicians and jugglers meet the criteria. To give visitors some idea of how the "magic" is created some models have been stripped down to show their mechanics while other displays show the elements which make up the automata.

Dex the Robot (Simon Blades, 1989) can be seen at the Museum of Automata, York.



MODERN VERSION

The modern robots or automata are less concerned with hiding their mechanics than with showing off how they perform their activities. Dex, which stands in the lobby is a perfect example of this. It has metal balls moving on various tracks around its body and is so fascinating that it often holds up the flow of visitors as they watch it before going into the museum.

Many of the modern automata encourage a hands-on approach from the visitors who can press buttons to activate them, some with their workings showing and some without. Possibly the most interesting are the ones where people provide the motive power such as the Wave Machine and an ingenious device which passes balls around, requiring cooperation by a number of people to get the ball from one position to another.

WORKSHOPS

Apart from the experience of going around the displays the museum is concerned with education in the wider sense, using the robots and exhibits to encourage an interest in craft and technology generally. As part of this the museum runs a series of workshops based around a visit followed by study of the mechanisms involved in the exhibits.

Workpacks are provided to go with the workshops, these are designed to meet the requirements of particular levels of the National Curriculum. And this year a competition has been held to design a piece of automata with a prize of £100. The response was excellent with entries from the large number of schools which have had the opportunity to take advantage of what the museum has to offer. The best of the entries will be put on display.

The growing reputation of the workshops can be gauged by the response to the series was offered in the early autumn. Within a few days of the series being promoted all the places were full.

Despite its success, or even because of it, the museum is looking at ways of developing and expanding its facilities. Only recently an extra room was added for use as a special exhibition area or for workshops.

As has often been noted in this column moving machines like robots and automata have a fascination for a large number of people. This museum enables them to feed their fascination in an accessible and interesting way.

THANKS

This is the last of the regular *Robot Roundups*. Many thanks to all those who have helped me to fill the column over the years and for your interest.

WINTER 1991/1992 CATALOGUE

OUT NOW!

- 100's of price reductions throughout the catalogue
- 200 pages
- Latest new products
- £££'s worth of discount vouchers
- On sale from 14th November at most large newsagents or directly from **Cirkit**

NEW LOW PRICES!

£1.70
plus 30p postage

Cirkit

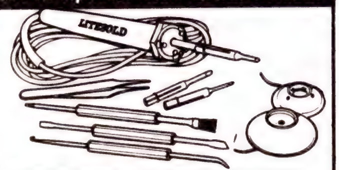
CIRKIT DISTRIBUTION LTD
Park Lane · Broxbourne · Hertfordshire · EN10 7NQ
Telephone (0992) 444111 · Fax (0992) 464457

Access VISA

JOIN UP WITH LITESOLD

Professional Soldering Equipment at Special Mail-Order Prices.

SK18 Soldering Kit. £17.28
Build or repair any electronic project. LC18 240v 18w iron with 3.2, 2.4, and 1.6mm bits. Pack of 18 swg flux-cored 60/40 solder. Tweezers. 3 soldering aids. Reel of De-Solder braid.



ADAMIN Miniature Iron £7.90

Possibly smallest mains iron in the world. Ideal for fine work. Slim nylon handle with finger grip. Interchangeable bits available. Fitted with 2.4mm. 240v 12w

'L' Series Lightweight Irons. 12w £8.34 **18w £8.41**

High efficiency irons for all electronic hobby work. Non-roll handles with finger guards. Stainless steel element shafts. Screw-connected elements. Slip-on bits available from 1.6 to 4.7mm. LA12 model, 12w, 2.4mm bit. LC 18 Model, 18w, 3.2mm bit. 240v Std

Soldering Iron Stands 3&4 £6.85

Designed specially for LITESOLD irons. Heavy, solid-plastic base with non-slip pads. Won't tip over, holds iron safely. With wiping sponge and location for spare (hot) bits.
No 4 stand for ADAMIN miniature Iron
No 3 stand for LA12 and LC18 Irons.

De-Solder Pumps £8.03

High Quality version of increasingly popular type of tool. Precision made anodised aluminium body, plunger guard and high-seal piston. Easy thumb operation. Automatic solder ejection. Conductive PTFE nozzle – no static problems.

Prices include p&p and VAT. Send order with Cheque/PO. Ring for Access/Visa sales

Access VISA

LIGHT SOLDERING DEVELOPMENTS LTD.
97-99 GLOUCESTER ROAD, CROYDON CR0 2DN. 081 689 0574

NEW DISCO KITS

SWITCHABLE 3-4 CHANNEL LIGHTING CONTROLLER.
With beatchase and speed controls.

PCB + Components Kit...£21.00
Hardware + punched case kit with label etc....................£12.00

MULTICHASE 4 CHANNEL LIGHTING CONTROLLER.
With chase select, beatchase and speed controls.

PCB + Components kit....£26.00
Hardware + punched case kit with label etc....................£13.00

COMPUTER CHASE 4 CHANNEL LIGHTING CONTROLLER.
With sound chase/sound to light automatic audio level. 3 superb programs including over 20 different chases.

PCB + Components Kit................£35.00
Hardware + punched case kit with label etc....................£15.00

All Hardware Kits include Bulgin 8 way socket, mains lead, mains switch, ¼" audio jack socket, cable restraint, feet and all fixings.
All Prices Include VAT. P&P only £1.50 per order.

NORTECH electronic
98 School Street, Wolverhampton, West Midlands WV3 0NR.
Tel: (0902) 23275

DIRECT BOOK SERVICE

The books listed have been selected by Everyday Electronics editorial staff as being of special interest to everyone involved in electronics and computing. They are supplied by mail order direct to your door. Full ordering details are given on the last book page. For another selection of books see next month's issue.

EVERYDAY ELECTRONICS DATA BOOK
Mike Tooley BA
(published by EE in association with PC Publishing)

This book is an invaluable source of information of everyday relevance in the world of electronics. It contains not only sections which deal with the essential theory of electronic circuits, but also deals with a wide range of practical electronic applications.

It is ideal for the hobbyist, student, technician and engineer. The information is presented in the form of a basic electronic recipe book with numerous examples showing how theory can be put into practice using a range of commonly available "industry standard" components and devices.

A must for everyone involved in electronics!

256 pages Order code DATA **£8.95**

ELECTRONICS TEACH-IN No. 3 – EXPLORING ELECTRONICS (published by *Everyday Electronics*)
Owen Bishop

Another EE value for money publication aimed at students of electronics. The course is designed to explain the workings of electronic components and circuits by involving the reader in experimenting with them. The book does not contain masses of theory or formulae but straightforward explanations and circuits to build and experiment with.

Exploring Electronics contains more than 25 useful projects, assumes no previous knowledge of electronics and is split into 28 easily digestible sections.

88 pages (A4 size) Order code TI3 **£2.45**

Special Everyday Electronics Books

ELECTRONICS TEACH-IN No.4
INTRODUCING DIGITAL ELECTRONICS (published by *Everyday Electronics*)
Michael J. Cockcroft

Although this book is primarily a City & Guilds Introductory level course (726/301), approximately 80% of the information forms a very basic introduction to electronics in general, it therefore provides an excellent introductory text for beginners and a course and reference book for GCSE students.

Full details on registering for C&G assessment, details of assessment centres, components required and information on the course in general are given.

The City & Guilds introduction to module 726/301 reads: "A candidate who satisfactorily completes this module will have a competence to identify basic components and digital integrated circuits and connect them together to form simple working circuits and logic units." This provides an excellent introduction to the book.

112 pages (A4 size) Order code TI4 **£2.95**

ELECTRONIC PROJECTS – BOOK 1
Published by *Everyday Electronics* in association with Magenta Electronics.

Contains twenty of the best projects from previous issues of EE each backed with a kit of components. The projects are: Seashell Sea Synthesiser, EE Treasure Hunter, Mini Strobe, Digital Capacitance Meter, Three Channel Sound to Light, BBC 16K Sideways Ram, Simple Short Wave Radio, Insulation Tester, Stepper Motor interface, Eprom Eraser, 200MHz Digital Frequency Meter, Infra Red Alarm, EE Equaliser Ioniser, Bat Detector, Acoustic Probe, Mains Tester and Fuse Finder, Light Rider – (Lapel Badge, Disco Lights, Chaser Light), Musical Doorbell, Function Generator, Tilt Alarm, 10W Audio Amplifier, EE Buccaneer Induction Balance Metal Detector, BBC Midi Interface, Variable Bench Power Supply, Pet Scarer, Audio Signal Generator.

128 pages (A4 size) Order code EP1 **£2.45**

ELECTRONICS TEACH-IN No.5 GUIDE TO BUILDING ELECTRONIC PROJECTS NEW
Published by EVERYDAY ELECTRONICS

Due to the demand from students, teachers and hobbyists we have put together a range of articles from past issues of *Everyday Electronics* that will assist those involved with the construction of electronic projects.

The book contains the complete *Project Development for GCSE* series.

Contents: Features – First Steps in Project Building; Building with Vero; Project Development for GCSE; Getting your Project Working; Guide to Printed Circuit Boards; Choosing and Using Test Equipment – The Multimeter, The Oscilloscope, P.S.U.s, Logic Probes, Digital Frequency Meters, Signal Generators, etc; **Data** – Circuit Symbols; Component Codes; Resistors; Identifying Components; Capacitors; Actually Doing It – Understanding the Circuit Diagram, Component Codes, Mounting circuit boards and controls, Understanding Capacitors; **Projects** – Lie Detector; Personal Stereo Amplifier; Digital Experimentsr's Unit; Quizmaster; Siren Effects Unit; UV Exposure Unit; Low-cost Capacitance Meter; Personal Radio.

88 pages (A4 size) Order code TI5 **£2.95**

ELECTRONICS TEACH-IN 88/89 – INTRODUCING MICROPROCESSORS
Mike Tooley BA (published by *Everyday Electronics*)

A complete course that can lead successful readers to the award of a City and Guilds Certificate in Introductory Microprocessors (726/303). The book contains everything you need to know including full details on registering for assessment, etc. Starting with basic terminology, integrated circuits, logic families and numbering systems the text builds in stages, with revision and assessments built in, up to programming, languages, flow charts, etc. The course is ideal for the newcomer to the subject.

80 pages (A4 size) Order code TI-88/89 **£2.45**

Computers and Computing

COMPUTERS AND MUSIC – AN INTRODUCTION
R. A. Penfold

Computers are playing an increasingly important part in the world of music, and the days when computerised music was strictly for the fanatical few are long gone. Computer-based music systems in the past have tended to be either horrendously expensive, very crude, or both! These days, prices are much more modest and the potential of the equipment is much greater. Consequently a lot of musicians are being tempted into the unfamiliar territory of computer music systems.

If you are more used to the black and white keys of a synth keyboard than the QWERTY keyboard of a computer, you may be understandably confused by the jargon and terminology bandied about by computer buffs. But fear not, setting up and using a computer-based music making system is not as difficult as you might think.

This book will help you learn the basics of computing, running applications programs, wiring up a MIDI system and using the system to good effect, in fact just about everything you need to know about hardware and the programs, with no previous knowledge of computing needed or assumed. This book will help you to choose the right components for a system to suit your personal needs, and equip you to exploit that system fully.

174 pages Order code PC107 **£7.95**

A CONCISE INTRODUCTION TO MS-DOS
N. Kantaris

This guide is written with the non-expert, busy person in mind and, as such, it has an underlying structure based on "what you need to know first, appears first". Nonetheless, the guide is also designed to be circular, which means that you don't have to start at the beginning and go to the end. The more experienced user can start from any section.

The guide covers versions 3.0, 3.1 and 3.2 of both PC-DOS and MS-DOS as implemented by IBM and other manufacturers of "compatible" microcomputers, including the AMSTRAD PC's. It covers both floppy disc-based systems and hard disc-based systems.

64 pages Order code BP232 **£2.95**

AN INTRODUCTION TO Z80 MACHINE CODE
R. A. & J. W. Penfold

Takes the reader through the basics of microprocessors and machine code programming with no previous knowledge of these being assumed. The Z80 is used in many popular home computers and simple programming examples are given for Z80-based machines including the Sinclair ZX-81 and Spectrum, Memotech and the Amstrad CPC 464. Also applicable to the Amstrad CPC 664 and 6128.

144 pages Order code BP152 **£2.75**

AN INTRODUCTION TO 68000 ASSEMBLY LANGUAGE
R. A. & J. W. Penfold

Obtain a vast increase in running speed by writing programs for 6800 based micros such as the Commodore Amiga, Atari ST range or Apple Macintosh range etc., in assembly language. It is not as difficult as one might think and this book covers the fundamentals.

112 pages Order code BP184 **£2.95**

THE ART OF PROGRAMMING THE ZX SPECTRUM
M. James, B.Sc., M.B.C.S.

It is one thing to have learnt how to use all the Spectrum's commands and functions, but a very different one to be able to combine them into programs that do exactly what you want them to. This is just what this book is all about – teaching you the art of effective programming with your Spectrum.

144 pages Order code BP119 **£2.50**

A Z80 WORKSHOP MANUAL
E. A. Parr, B.Sc., DC.Eng., M.I.E.E.

This book is intended for people who wish to progress beyond the stage of BASIC programming to topics such as machine code and assembly language programming, or need hardware details of a Z80 based computer.

192 pages Order code BP112 **£3.95**

NEWNES COMPUTER ENGINEER'S POCKETBOOK (Second Edition)
Michael Tooley

An invaluable compendium of facts, figures, circuits and data, indispensable to the designer, student, service engineer and all those interested in computer and microcomputer systems. It will appeal equally to the hardware or software specialist and to the new band of "software engineers". This data is presented in a succinct and rapidly accessible form so that the book can become part of an everyday toolkit.

205 pages (hard cover) Order code NE01 **£10.95**

UNDERSTANDING PC SPECIFICATIONS
R. A. Penfold

If you require a microcomputer for business applications, or a high quality home computer, an IBM PC or compatible is often the obvious choice. They are competitively priced, and are backed up by an enormous range of applications programs, hardware add-ons, etc. The main difficulty for the uninitiated is deciding on the specification that will best suit his or her needs. PCs range from simple systems of limited capabilities up to complex systems that can happily run applications that would have been considered beyond the abilities of a microcomputer not so long ago. It would be very easy to choose a PC system that is inadequate to run your applications efficiently, or one which goes beyond your needs and consequently represents poor value for money.

This book explains PC specifications in detail, and the subjects covered include the following: Differences between types of PC (XT, AT, 80386, etc); Maths co-processors; Input devices (keyboards, mice, and digitisers); Memory, including both expanded (EMS) and extended RAM: RAM disks and disk caches; Floppy disk drive formats and compatibility; Hard disk drives (including interleave factors and access times); Display adaptors, including all standard PC types (CGA, Hercules, Super VGA, etc); Contains everything you need to know if you can't tell your EMS from your EGA!

104 pages Order code BP282 **£3.95**

Theory and Reference

ELECTRONIC HOBBYISTS HANDBOOK
R. A. Penfold

Provides an inexpensive single source of easily located information that the amateur electronics enthusiast is likely to need for the day-to-day pursuance of this fascinating hobby. Covers common component colour codes. Details the characteristics and pinouts of many popular seimiconductor devices, including various types of logic ICs, operational amplifiers, transistors, FETs, unijunctions, diodes, rectifiers, SCRs, diacs, triacs, regulators and SMDs, etc. Illustrates many useful types of circuits, such as timers and oscillators, audio amplifiers and filters, as well as including a separate section on power supplies. Also contains a multitude of other useful data.

88 pages Temporarily out of print

ESSENTIAL THEORY FOR THE ELECTRONICS HOBBYIST
G. T. Rubaroe, T. Eng (C.E.I.), Assoc.I.E.R.E.

The object of this book is to supply the hobbyist with a background knowledge tailored to meet his or her specific requirements and the author has brought together the relevant material and presented it in a readable manner with minimum recourse to mathematics.

128 pages Order code 228 **£2.50**

NEWNES ELECTRONICS POCKET BOOK
E. A. Parr

Newnes Electronics Pocket Book has been in print for over twenty years and has covered the development of electronics from valve to semiconductor technology and from transistors to LSI integrated circuits and microprocessors. To keep up to date with the rapidly changing world of electronics, continuous revision has been necessary. This new Fifth Edition takes account of recent changes and includes material suggested by readers of previous editions. New descriptions of op.amp. applications and the design of digital circuits have been added, along with a totally new chapter on computing, plus other revisions throughout.

315 pages (hard cover) Order code NE02 **£10.95**

ELECTRONICS – A "MADE SIMPLE" BOOK
G. H. Olsen

This book provides excellent background reading for our *Introducing Digital Electronics Teach-In* Book and will be of interest to everyone studying electronics. The subject is simply explained and well illustrated and the book assumes only a very basic knowledge of electricity.

330 pages Order code NE10 **£4.95**

PRACTICAL DIGITAL ELECTRONICS HANDBOOK
Mike Tooley (Published in association with *Everyday Electronics*)

The vast majority of modern electronic systems rely heavily on the application of digital electronics, and the *Practical Digital Electronics Handbook* aims to provide readers with a practically based introduction to this subject. The book will prove invaluable to anyone involved with the design, manufacture or servicing of digital circuitry, as well as to those wishing to update their knowledge of modern digital devices and techniques. Contents: Introduction to integrated circuits; basic logic gates; monostable and bistable devices; timers; microprocessors; memories; input and output devices; interfaces; microprocessor buses. Appendix 1: Data. Appendix 2: Digital test gear projects; tools and text equipment; regulated bench power supply; logic pulser; verstaile pulse generator; digital IC tester; current tracer; audio logic tracer; RS-232C breakout box; versatile digital counter/frequency meter. Appendix 3: The oscilloscope. Appendix 4: Suggested reading. Appendix 5: Further study.

208 pages Order code PC100 **£6.95**

ELECTRONIC MODULES AND SYSTEMS FOR BEGINNERS
Owen Bishop

This book describes over 60 modular electronic circuits – how they work, how to build them, and how to use them. The modules may be wired together to make hundreds of different electronic systems, both analogue and digital. To show the reader how to begin building systems from modules, a selection of over 25 electronic systems are described in detail, covering such widely differing applications as timing, home security, measurement, audio (including a simple radio receiver), games and remote control.

200 pages Order code BP266 **£3.95**

FROM ATOMS TO AMPERES
F. A. Wilson

Explains in crystal clear terms the absolute fundamentals behind electricity and electronics. Really helps you to discover and understand the subject, perhaps for the first time ever.

Have you ever: Wondered about the true link between electricity and magnetism? Felt you could never understand the work of Einstein, Newton, Boltzmann, Planck and other early scientists? Just accepted that an electron is like a little black ball? Got mixed up with e.m.f. and p.d.? Thought the idea of holes in semiconductors is a bit much?

Then help is at hand with this inexpensive book, in as simple a way as possible and without too much complex mathematics and formulae.

244 pages Order code BP254 **£3.50**

Project Building

HOW TO GET YOUR ELECTRONIC PROJECTS WORKING
R . A. Penfold

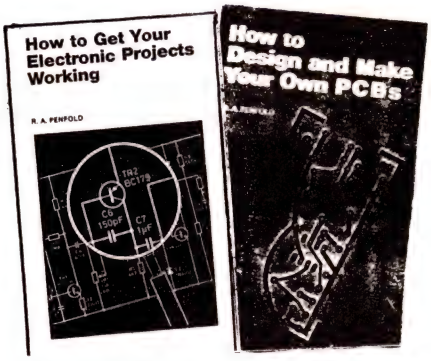
We have all built projects only to find that they did not work correctly, or at all, when first switched on. The aim of this book is to help the reader overcome just these problems by indicating how and where to start looking for many of the common faults that can occur when building up projects.

96 pages Order code BP110 **£2.50**

HOW TO DESIGN AND MAKE YOUR OWN P.C.B.s
R. A. Penfold

Deals with the simple methods of copying printed circuit board designs from magazines and books and covers all aspects of simple p.c.b. construction including photographic methods and designing your own p.c.b.s.

80 pages Order code BP121 **£2.50**


How to Get Your Electronic Projects Working
R. A. PENFOLD
How to Design and Make Your Own PCBs

A BEGINNERS GUIDE TO MODERN ELECTRONIC COMPONENTS
R. A. Penfold

The purpose of this book is to provide practical information to help the reader sort out the bewildering array of components currently on offer. An advanced knowledge of the theory of electronics is not needed, and this book is not intended to be a course in electronic theory. The main aim is to explain the differences between components of the same basic type (e.g. carbon, carbon film, metal film, and wire-wound resistors) so that the right component for a given application can be selected. A wide range of components are included, with the emphasis firmly on those components that are used a great deal in projects for the home constructor.

166 pages Order code BP285 **£3.95**

BEGINNER'S GUIDE TO BUILDING ELECTRONIC PROJECTS
R. A. Penfold

Shows the complete beginner how to tackle the practical side of electronics, so that he or she can confidently build the electronic projects that are regularly featured in magazines and books. Also include examples in the form of simple projects.

112 pages Order code 227 **£1.95**

ELECTRONIC SCIENCE PROJECTS
O. Bishop

These projects range in complexity from a simple colour temperature meter to an infra-red laser. There are novelties such as an electronic clock regulated by a resonating spring, and an oscilloscope with solid-state display. There are scientific measuring instruments such as a pH meter and an electro-cardiometer. All projects have a strong scientific flavour. The way they work, and how to build and use them are fully explained.

144 pages Order code BP104 **£2.95**

ELECTRONICS SIMPLIFIED – CRYSTAL SET CONSTRUCTION
F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.

Especially written for those who wish to participate in the intricacies of electronics more through practical construction than by theoretical study. It is designed for all ages upwards from the day one can read intelligently and handle simple tools.

80 pages Order code BP92 **£1.75**

Component Identification

HOW TO IDENTIFY UNMARKED ICs
K. H. Recorr

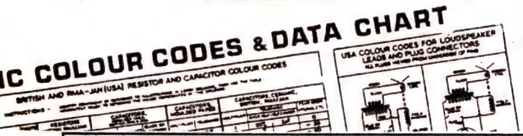
Shows the reader how, with just a test-meter to go about recording the particular signature of an unmarked i.c. which should enable the i.c. to then be identified with reference to manufacturers' or other data. An i.c. signature is a specially plotted chart produced by measuring the resistances between all terminal pairs of an i.c.

Chart Order code BP101 **£0.95**

RADIO AND ELECTRONIC COLOUR CODES AND DATA CHART
B. B. Babani

Although this chart was first published in 1971 it provides basic information on many colour codes in use throughout the world, for most radio and electronic components. Includes resistors, capacitors, transformers, field coils, fuses, battery leads, speakers, etc. It is particularly useful for finding the values of old components.

Chart Order code BP7 **£0.95**


IC COLOUR CODES & DATA CHART
BRITISH AND RMA-JAN (USA) RESISTOR AND CAPACITOR COLOUR CODES
INSTRUCTIONS -
USA COLOUR CODES FOR LOUDSPEAKER LEADS AND PLUG CONNECTORS

Testing and Test Gear

TRANSISTOR RADIO FAULT-FINDING CHART
C. E. Miller

Used properly, should enable the reader to trace most common faults reasonably quickly. Across the top of the chart will be found four rectangles containing brief descriptions of these faults, *vis* – sound weak but undistorted, set dead, sound low or distorted and background noises. One then selects the most appropriate of these and following the arrows, carries out the suggested checks in sequence until the fault is cleared.

Chart Order code BP70 **£0.95**

HOW TO USE OSCILLOSCOPES AND OTHER TEST EQUIPMENT
R. A. Penfold

This book explains the basic function of an oscilloscope, gives a detailed explanation of all the standard controls, and provides advice on buying. A separate chapter deals with using an oscilloscope for fault finding on linear and logic circuits. Plenty of example waveforms help to illustrate the control functions and the effects of various fault conditions. The function and use of various other pieces of test equipment are also covered, including signal generators, logic probes, logic pulsers, and crystal calibrators.

104 pages Order code BP267 **£3.50**

Audio and Music

PRACTICAL MIDI HANDBOOK
R. A. Penfold

The Musical Instrument Digital Interface (MIDI) is surrounded by a great deal of misunderstanding, and many of the user manuals that accompany MIDI equipment are quite incomprehensible to the reader.

The Practical MIDI Handbook is aimed primarily at musicians, enthusiasts and technicians who want to exploit the vast capabilities of MIDI, but who have no previous knowledge of electronics or computing. The majority of the book is devoted to an explanation of what MIDI can do and how to exploit it to the full, with practical advice on connecting up a MIDI system and getting it to work, as well as deciphering the technical information in those equipment manuals.

128 pages Order code PC101 **£6.95**

MUSICAL APPLICATIONS OF THE ATARI ST's
R. A. Penfold

The Atari ST's are now firmly established as *the* computers to use for electronic music applications. The range and sophistication of these applications are much greater than most people may realise, but there are still a lot of misconceptions about just what can and cannot be achieved. This book will help you sort out the fact from the fallacy and to get the most musically from the ST's.

A wide selection of topics are covered, including the internal sound chip; MIDI; applications programs such as sequencing and score writing, etc; simple but useful add-on projects and MIDI programming.

90 pages Order code BP246 **£5.95**

AN INTRODUCTION TO LOUDSPEAKERS AND ENCLOSURE DESIGN
V. Capel

This book explores the various features, good points and snags of speaker designs. It examines the whys and wherefores so that the reader can understand the principles involved and so make an informed choice of design, or even design loudspeaker enclosures for him or herself. Crossover units are also explained, the various types, how they work, the distortions they produce and how to avoid them. Finally there is a step-by-step description of the construction of the *Kapellmeister* loudspeaker enclosure.

148 pages Order code BP256 **£2.95**

COMPUTERS AND MUSIC. See Computers section opposite

Circuits and Design

PRACTICAL ELECTRONIC BUILDING BLOCKS – BOOK 1

PRACTICAL ELECTRONIC BUILDING BLOCKS – BOOK 2
R. A. Penfold
These books are designed to aid electronic enthusiasts who like to experiment with circuits and produce their own projects, rather than simply following published project designs.

BOOK 1 contains: Oscillators – sinewave, triangular, squarewave, sawtooth, and pulse waveform generators operating at audio frequencies. Timers – simple monostable circuits using i.c.s, the 555 and 7555 devices, etc. Miscellaneous–noise generators, rectifiers, comparators and triggers, etc.

BOOK 2 contains: Amplifiers – low level discrete and op-amp circuits, voltage and buffer amplifiers including d.c. types. Also low-noise audio and voltage controller amplifiers. Filters – high-pass, low-pass, 6, 12, and 24dB per octave types. Miscellaneous – i.c. power amplifiers, mixers, voltage and current regulators, etc.

BOOK 1 *128 pages* Order code BP117 **£1.95**
BOOK 2 *112 pages* Order code BP118 **£1.95**

MODERN OPTO DEVICE PROJECTS
R. A. Penfold
In recent years, the range of opto devices available to the home constructor has expanded and changed radically. These devices now represent one of the more interesting areas of modern electronics for the hobbyist to experiment in, and many of these have useful practical applications as well. This book provides a number of practical designs which utilize a range of modern opto-electrical devices, including such things as fibre optics, ultra bright l.e.d.s and passive IR detectors etc.

While many of these designs are not in the "dead simple" category, they should be within the capabilities of anyone with a reasonable amount of experience in electronics construction and some of the more simple designs are suitable for beginners.

104 pages Order code BP194 **£2.95**

ELECTRONIC ALARM CIRCUITS MANUAL
R. M. Marston
One hundred and forty useful alarm circuits, of a variety of types, are shown in this volume. The operating principle of each one is explained in concise but comprehensive terms, and brief construction notes are given where necessary.

Aimed at the practical design engineer, technician and experimenter, as well as the electronics student and amateur.

124 pages Order code NE11 **£12.95**

DIGITAL LOGIC GATES AND FLIP-FLOPS
Ian R. Sinclair
This book, intended for enthusiasts, students and technicians, seeks to establish a firm foundation in digital electronics by treating the topics of gates and flip-flops thoroughly and from the beginning. This is not a constructor's book in the sense of presenting circuits to build and use, it is for the user who wants to design and troubleshoot digital circuitry with considerably more understanding of principles.

Topics such as Boolean algebra and Karnaugh mapping are explained, demonstrated and used extensively, and more attention is paid to the subject of synchronous counters than to the simple but less important ripple counters.

No background other than a basic knowledge of electronics is assumed, and the more theoretical topics are explained from the beginning, as also are many working practices. The book concludes with an explanation of microprocessor techniques as applied to digital logic.

200 pages Order code PC106 **£8.95**

ELECTRONIC CIRCUITS FOR THE COMPUTER CONTROL OF ROBOTS
Robert Penfold
Robots and robotics offer one of the most interesting areas for the electronics hobbyist to experiment in. Today the mechanical side of robots is not too difficult, as there are robotics kit and a wide range of mechanical components available. The micro controller is not too much of a problem either, since the software need not be terribly complex and many inexpensive home computers are well suited to the task.

The main stumbling block for most would-be robot builders is the electronics to interface the computer to the motors, and the sensors which provide feedback from the robot to the computer. The purpose of this book is to explain and provide some relatively simple electronic circuits which bridge this gap.

92 pages Order code BP179 **£2.95**

ELECTRONIC POWER SUPPLY HANDBOOK
Ian R. Sinclair
This book covers the often neglected topic of electronic power supplies. All types of supplies that are used for electronics purposes are covered in detail, starting with cells and batteries and extending by way of rectified supplies and linear stabilisers to modern switch-mode systems, IC switch-mode regulators, DC-DC converters and inverters.

The devices, their operating principles and typical circuits are all dealt with in detail. The action of rectifiers and the reservoir capacitor is emphasised, and the subject of stabilisation is covered. The book includes some useful formulae for assessing the likely hum level of a conventional rectifier reservoir supply.

136 pages Order code PC108 **£7.95**

HOW TO USE OP-AMPS
E. A. Parr
This book has been written as a designer's guide covering many operational amplifiers, serving both as a source book of circuits and a reference book for design calculations. The approach has been made as non-mathematical as possible.

160 pages Order code BP88 **£2.95**

MICRO INTERFACING CIRCUITS – BOOK 1
MICRO INTERFACING CIRCUITS – BOOK 2
R. A. Penfold
Both books include practical circuits together with details of the circuit operation and useful background information. Any special constructional points are covered but p.c.b. layouts and other detailed constructional information are not included.

Book 1 is mainly concerned with getting signals in and out of the computer; Book 2 deals primarily with circuits for practical applications.

BOOK 1 *112 pages* Order code BP130 **£2.75**
BOOK 2 *112 pages* Order code BP131 **£2.75**

SENSORS AND TRANSDUCERS
Keith Brindley
There are a considerable number of transducers. Look through any electronic components catalogue and you'll find a wide variety of types, and each type has many versions. It's not easy to choose a transducer correctly for a particular function. In many specifications, terms and procedures are referred to which might deter you from using one that is, in fact, the best for the job. Yet, opting to use a transducer merely because it is easier to interface into the measuring system is not the answer. A greater knowledge of all types of transducers capable of doing the task is the ideal, and only then can a totally satisfactory decision be made to use one in particular.

179 pages Order code NE17 **£14.95**

50 SIMPLE LED CIRCUITS
R. N. Soar
Contains 50 interesting and useful circuits and applications, covering many different branches of electronics, using one of the most inexpensive and freely available components – the light-emitting diode (LED). Also includes circuits for the 707 common anode display.

64 pages Order code BP42 **£1.95**

BOOK 2 50 more l.e.d. circuits Order code BP87 **£1.95**

Radio, TV, Satellite

AN INTRODUCTION TO AMATEUR RADIO
I. D. Poole
Amateur radio is a unique and fascinating hobby which has attracted thousands of people since it began at the turn of the century.

This book gives the newcomer a comprehensive and easy to understand guide through the subject so that the reader can gain the most from the hobby. It then remains an essential reference volume to be used time and again. Topics covered include the basic aspects of the hobby, such as operating procedures, jargon and setting up a station. Technical topics covered include propagation, receivers, transmitters and aerials etc.

150 pages Order code BP257 **£3.50**

SIMPLE SHORT WAVE RECEIVER CONSTRUCTION
R. A. Penfold
Short wave radio is a fascinating hobby, but one that seems to be regarded by many as an expensive pastime these days. In fact it is possible to pursue this hobby for a minimal monetary outlay if you are prepared to undertake a bit of d.i.y., and the receivers described in this book can all be built at low cost. All the sets are easy to construct, full wiring diagrams etc. are provided, and they are suitable for complete beginners. The receivers only require simple aerials, and do not need any complex alignment or other difficult setting up procedures.

The topics covered in this book include: The broadcast bands and their characteristics; The amateur bands and their characteristics; The propagation of radio signals; Simple aerials; Making an earth connection; Short wave crystal set; Simple t.r.f. receivers; Single sideband reception; Direct conversion receiver.

Contains everything you need to know in order to get started in this absorbing hobby.

88 pages Order code BP275 **£3.95**

AN INTRODUCTION TO SATELLITE TELEVISION
F. A. Wilson
As a definitive introduction to the subject this book is presented on two levels. For the absolute beginner or anyone thinking about purchasing or hiring a satellite TV system, the story is told as simply as such a complex one can be in the main text.

For the professional engineer, electronics enthusiast, student or others with technical backgrounds, there are numerous appendices backing up the main text with additional technical and scientific detail formulae, calculations, tables etc. There is also plenty for the DIY enthusiast with practical advice on choosing and installing the most problematic part of the system – the dish antenna.

104 pages Order code BP195 **£5.95**

AN INTRODUCTION TO AMATEUR COMMUNICATIONS SATELLITES
A. Pickford
Communications and broadcast satellites are normally inaccessible to individuals unless they are actively involved in their technicalities by working for organisations such as British Telecom, the various space agencies or military bodies. even those who possess a satellite television receiver system do not participate in the technical aspects of these highly technological systems.

There are a large number of amateur communications satellites in orbit around the world, traversing the globe continuously and they can be tracked and their signals received with relatively inexpensive equipment. This equipment can be connected to a home computer such as the BBC Micro or IBM compatible PCs, for the decoding of received signals.

This book describes several currently available systems, their connection to an appropriate computer and how they can be operated with suitable software.

102 pages Order code BP290 **£3.95**

AERIAL PROJECTS
R. A. Penfold
The subject of aerials is vast but in this book the author has considered practical aerial designs, including active, loop and ferrite aerials which give good performances and are relatively simple and inexpensive to build. The complex theory and mathematics of aerial design have been avoided.

Also included are constructional details of a number of aerial accessories including a pre-selector, attenuator, filters and tuning unit.

96 pages Order code BP105 **£2.50**

INTERNATIONAL RADIO STATIONS GUIDE
P. Shore
Provides the casual listener, amateur radio DXer and the professional radio monitor with an essential reference work designed to guide him or her around the ever more complex radio bands. This new edition has been completely revised and rewritten and incorporates much more information which is divided into the following sections:

Listening to Short Wave Radio; Choosing a Short Wave Radio Receiver; How to Use the IRSG; Abbreviations; Country Codes; Worldwide Short Wave Radio Stations; European, Middle Eastern and African Long Wave Radio Stations; European, Near and Middle Eastern and African Medium Wave Radio Stations; Canadian Medium Wave Radio Stations; USA Medium Wave Radio Stations; Broadcasts in English; Programmes for DXers and Short Wave Listeners; UK FM Radio Stations; Time Differences From GMT; Wavelength/Frequency Conversion.

226 pages Order code BP255 **£5.95**

DIRECT BOOK SERVICE

ORDERING DETAILS

Please state the title and order code clearly, print your name and address and add the required postage to the total order.

Add 75p to your total order for postage and packing (overseas readers **add £1.50** for countries in Europe, or **add £2.50** for all countries outside Europe, surface mail postage) and send a PO, cheque, international money order, (£ sterling only) made payable to **Direct Book Service** or credit card details (including the card expiry date), Visa or Mastercard (Access) – minimum credit card order is £5 – quoting your name and address, the order code and quantities required to DIRECT BOOK SERVICE, 33 GRAVEL HILL, WIMBORNE, DORSET BH21 1RW (mail order only).

Although books are normally sent within seven days of receipt of your order, please allow a maximum of 28 days for delivery. Overseas readers allow extra time for surface mail post.

Please check price and availability (see latest issue of Everyday Electronics) before ordering from old lists.

Note – our postage charge is the same for one book or one hundred books!

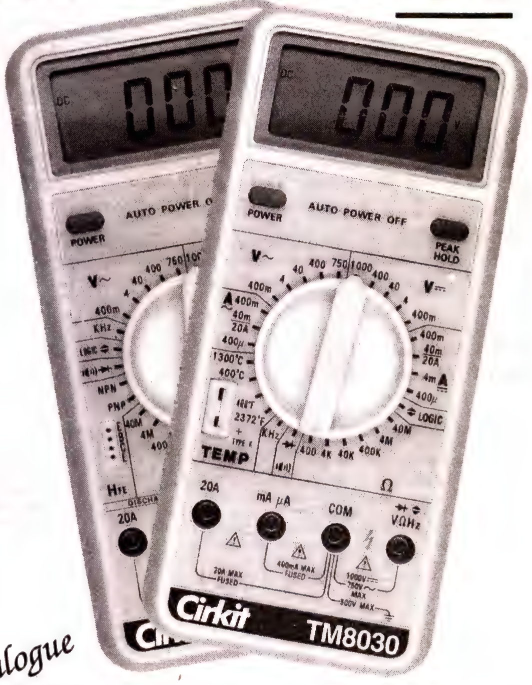
MORE BOOKS NEXT MONTH

Direct Book Service is a division of Wimborne Publishing Ltd

NEW MULTIMETERS!

A NEW RANGE OF HIGH SPECIFICATION DIGITAL MULTIMETERS FROM CIRKIT

- 3¾,17mm LC display
- IEC 348 II safety standard
- Tough, splash proof ABS case
- Current ranges protected by high energy cartridge fuses
- 0.5% basic dc accuracy
- Ranges include; frequency, capacitance and temperature



TM8020

dc volts:	400mV-1kV
ac volts:	400mV-750V
dc current:	400mA-20A
ac current:	400mA-20A
resistance:	400Ω-40MΩ
capacitance:	4nF-40uF
frequency:	4kHz-4MHz (autoranging)

Continuity, diode, HFE and logic test

£59.98

TM8030

dc volts:	400mV-1kV
ac volts:	400mV-750V
dc current:	400uA-20A
ac current:	400uA-20A
resistance:	400Ω-40MΩ
temperature:	400°C, 1300°C/400°F, 2372°
frequency:	4kHz-4MHz (autoranging)

Continuity, diode and logic test

£65.20

Cirkit

Prices include VAT at 17.5%
Please add £1.20 for
postage and packing

Full Catalogue **£1.70** + 30p p&p

Access VISA

CIRKIT DISTRIBUTION LTD
Park Lane · Broxbourne · Hertfordshire · EN10 7NQ
Telephone (0992) 444111 · Fax (0992) 464457

ILP AMPLIFIERS FROM JAYTEE

The UK Distributor for the complete ILP Audio Range

* Bipolar Modules – 15 watts to 180 watts
* Mosfet Modules – 60 watts to 180 watts
* Power Supplies
* Pre-amplifier Modules
* 100 volt Line Transformers
* Power Slave Amplifiers

Write or phone for free Data Pack

Jaytee Electronic Services
143 Reculver Road, Beltinge, Herne Bay, Kent CT6 6PL
Telephone: (0227) 375254

electronize CAR ALARM KITS

MICRO-PRESSURE CAR ALARM

This new type of alarm is triggered by a unique pressure sensing system. As any vehicle door is opened air is drawn out, causing a minute drop in air pressure. A sensor detects this sudden pressure change and sets off the alarm. An electronic filter, tuned to only 3Hz., and adjustable sensitivity avoid false alarms whilst an arrangement of timers provide automatic operation.

☆ **Operates on all doors and tailgate - no switches needed.**
☆ **Automatically armed 40 seconds after leaving vehicle.**
☆ **10 second entry delay with audible warning. (0.5 second available.)**
☆ **Sounds horn or siren intermittently for 30 seconds - then re-arms.**
☆ **Easy fitting - only 3 wires to connect - no holes to drill.**
☆ **Controlled by ignition switch, hidden switch or coded remote control.**
(The optional siren and coded remote control are supplied separately.)

MICRO-PRESSURE ALARM	Parts kit £15.95	Assembled £22.35

NEW CODED IR REMOTE CONTROL

Our latest addition allows control of our alarms from outside the vehicle. Both transmitter and receiver use a chip designed specially for car security systems with 59,046 code combinations. You can even set your own code, with several vehicles on the same code or several transmitters for one vehicle if required.

☆ **High security, customer selected, 24 bit code.**
☆ **Key-ring transmitter with long life minature alkaline battery.**
☆ **High power infra-red emitter with range up to 5 metres.**
☆ **Low profile dash top receiver/decoder.**
☆ **Flashing high intensity red L.E.D. warns off intruders.**
☆ **Green L.E.D. shows alarm is off.**

Use the coded transmitter and receiver with our Micro-Pressure or Volt Drop alarm to form a coded remote controlled system.

CODE TRANSMITTER	Parts kit £13.95	Assembled £17.95
CODE RECEIVER	Parts kit £21.35	Assembled £26.55

Also available :-

VOLT DROP CAR ALARM	Parts kit £14.90	Assembled £20.95
120dB PIEZO SIREN		Assembled £11.95
MICRO-PRESSURE TRIGGER	Parts kit £10.95	Assembled £14.95
EXTENDED CDI IGNITION	Parts kit £22.75	Assembled £28.45

All the above include cable, connectors and clear easy to follow instructions.
All kits include case, PCB, everything down to the last washer, even solder.
All prices now include post, packing and VAT on U.K. orders. Same prices apply to all European countries. For delivery outside Europe please add £3.
Telephone orders accepted with VISA or ACCESS payment.
Order direct (please quote ref. E1C) or send for more details from :-

ELECTRONIZE DESIGN Tel. 021 308 5877
2 Hillside Road, Four Oaks, Sutton Coldfield, B74 4DQ

PCB SERVICE

Printed circuit boards for certain constructional projects are available from the PCB Service, see list. These are fabricated in glass fibre, and are fully drilled and roller tinned. All prices include VAT and postage and packing. Add £1 per board for airmail outside of Europe. Remittances should be sent to **The PCB Service, *Everyday Electronics,* 6 Church Street, Wimborne, Dorset BH21 1JH.** Cheques should be crossed and made payable to *Everyday Electronics* **(Payment in £ sterling only).**

NOTE: While 95% of our boards are now held in stock and are dispatched within seven days of receipt of order, please allow a maximum of 28 days for delivery – overseas readers allow extra if ordered by surface mail. Please check price in the latest issue.

Boards can only be supplied on a payment with order basis.

We do have older boards in stock – please enquire.

PROJECT TITLE		Order Code	Cost
4-Channel Auto-Fade Interface	APR'89	642	£6.80
Electron A/D Interface	MAY'89	645	£4.84
Spectrum EPROM Programmer	JUN'89	628	£7.87
Bat Detector		647	£4.95
Programmable Pocket Timer	JUL'89	648	£3.82
Electronic Spirit Level	AUG'89	649	£3.85
Distance Recorder		651	£5.23
Xenon Beacon	SEP'89	650	£4.13
Power Supplies – Fixed Voltage		654	£4.08
Variable Voltage		655	£4.48
Music on Hold	OCT'89	646	£3.85
Power Supplies – 25V 700mA		656	£4.35
30V 1A		657	£4.55
EE Seismograph – Control		658	£4.08
Detector		659	£4.22
Lego/Logo & Spectrum		660	£6.49
Wash Pro	NOV'89	643	£3.83
Biofeedback Monitor – Front End		661	£4.52
Processor		662	£4.56
Logo/Lego & Spectrum Interface		664	£5.60
EEG Electrode Impedance Meter	DEC'89	665	£3.98
Biofeedback Signal Generator	JAN'90	666	£4.08
Quick Cap Tester	FEB'90	668	£3.92
Weather Station			
Anemometer – Freq./Volt Board		670	£3.94
Optional Display		669	£3.73
Wind Direction		673/674	£4.22
System Power Supply		675	£3.59
Prophet In-Car Ioniser		676	£3.18
EE Weather Station	MAR'90		
Display Driver		672 & 678	£4.22
Display and Sensor		671	£4.47
Fermostat Mk2		677	£4.28
Superhet Broadcast Receiver- Tuner/Amp		679/680	£4.22
Stereo Noise Generator	APR'90	681	£4.24
Digital Experimenter's Unit – Pulse Generator		682	£4.46
Power Supply		683	£3.66
Enlarger Timer		684	£4.28
EE Weather Station			
Rainfall/Sunlight Display		685	£4.27
Rainfall Sen and Sunlight Sen		686/687	£4.16
Amstrad Speech Synthesiser	MAY'90	689	£4.68
80 Metre Direct Conversion Radio	JUN'90	691	£4.95
Mains Appliance Remote Control Infra-Red Transmitter		692/693	£4.75
Mains Appliance Remote Control	JUL'90		
Encoder Board A		694	£6.61
Encoder Board B		695	£4.78
The Tester		696	£4.15
Mains Appliance Remote Control	AUG'90		
Mains ON/OFF Decoder (5 or more 697's ordered *together* £3.25 each)		697	£4.55
Simple Metronome		698	£3.94
Hand Tally	SEP'90		
Main Board (double-sided) and Display Board		699, 700	£10.95
Alarm Bell Time-Out		701	£4.10
Mains Appliance Remote Control Temperature Controller (p.c.b. only)		702	£5.20
Ghost Waker	OCT'90	703	£4.32
Frequency Meter		704	£5.25
Freq. Meter/Tachometer	NOV'90	705	£3.98
EE Musketeer (TV/Video/Audio)		706	£5.78
Colour Changing Christmas Lights	DEC'90	707	£4.39
Microcontroller Light Sequencer		708/709	£10.90
Versatile Bench Power Supply Unit		710	£4.24
Teach-In '91, Part 1 – L200 Module		711	£3.93
Dual Output Module		712	£4.13
LM723 Module		713	£4.21
Spatial Power Display	JAN'91	714	£5.33
Amstrad PCW Sound Generator		715	£5.03
Teach-In '91, Part 2 – G.P. Transistor Amp		717	£3.77
Dual Op.Amp Module		718	£3.83
Intercom (Teach-In '91 Project 2)		719	£4.41
Analogic Test Probe		720	£3.24
MARC Phone-In	FEB'91	721	£6.87
Teach-In '91 Part 3 – TBA820M Amplifier		723	£4.05
High Quality Power Amp		724	£4.93
Bench Amplifier (Teach-In '91 Project 3)		725	£4.45
Gingernut 80m Receiver			
R.F. section (726), Voltage Regulator (727)		726/7/8	£3.06
Audio Amplifier (728)			per board
		all 3 together	£8.16
Pocket Tone Dialler	MAR'91	729	£4.36
Battery To Mains Inverter		730	£4.97
Simple Basic Alarm		731	£4.50
Car Code Lock (pair)		732a/b	£4.69
Teach-In '91 Part 4 – Sinusoidal Oscillator		733	£4.39
8038 Oscillator		734	£4.15
Waveform Generator (Teach-In '91 Project 4)		735	£4.72
Humidity Tester	APR'91	716	£4.97
Model Train Controller (double-sided)		736	£9.75
Electronic Die (Teach-In '91 Project 5)		737	£4.93
Teach-In '91 Part 5 – Digital Counter Module		738	£4.35
Modular Disco Lighting System	MAY'91		
Switched Power Output Module		739	£5.91
Digital LCD Thermostat–Control Board	£5 for pair	740	£4.05
–Power/Relay Board		741	£3.76
Pulse Generator (Teach-In '91 Project 6)		742	£4.97
Teach-In '91 Part 6 – Timer Module		743	£4.62
Digilogue Car Tachometer	JUN'91	744	£5.63
Modular Disco Lights – Simple Chaser		745	£5.00
Sweeper Module		746	£5.17
Automatic Light Control – PSU Board		747	£4.88
Logic Board		748	£5.17
Radio Receiver (Teach-In '91 Project 7)		749	£4.57
Teach-In '91 Part 7 – R.F. Amplifier Module		750	£4.23
Modular Disco Lights – Masterlink	JULY'91	752	£6.36
Ultrasonic Proximity Meter Display Unit (753) & Sensor Unit (754)		753/754	£7.06
Disco Lights (Teach-In '91 Project 8)			
PSU and Pre-amplifier		755	£4.54
Low, Mid, High Filter/Triac (set of 3 boards)		756	£11.00
Teach-In '91 Part 8 – Solid State Switch Module		757	£4.24
Mod. Disco Lights – Pattern Gen	AUG'91	760	£6.79
Teach-In '91 Part 8–Light Sensitive Switch		761	£4.74
Opto-Link (Teach-In '91 Project 9) – Transmitter		762	£4.85
Receiver		763	£4.88
Portable PEsT Scarer		764	£3.77
Capacitance Meter	SEP'91	751	£5.17
Modular Disco Lights – Dimmer Interface		765	£8.17
Mod. Disco Lights	OCT'91		
VU Sound Module (Double-sided)		767	£8.68
UV Exposure Unit		768	£4.63
PC-Scope Interface – Main Board		769	£6.95
Expansion Plug (Double-sided)		770	£5.96
Mod. Disco Lights	NOV'91		
Superchaser (Double-sided)		771	£6.91
Supersweep (Double-sided)		772	£8.26
Bicycle Alarm		773	£5.01
Darts Scorer		774	£7.90
Knockerbox	DEC'91	775	£5.35
Signal Generator – Main Board		776	£7.46
PSU		777	£4.73
Mind Machine – Main Board		778	£7.00
Auto Nightlight		779	£5.03

EE PRINTED CIRCUIT BOARD SERVICE

Order Code **Project** **Quantity** **Price**

....

Name..

Address..

....

I enclose payment of £ .... (cheque/PO in **£ sterling only** payable to Everyday Electronics) Access (MasterCard) or Visa No.

Minimum order for credit cards £5

☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

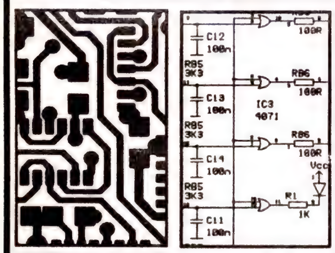
Signature..Card Ex. Date..............................

Please supply name and addess of card-holder if different from the address shown

BLOCK CAPITALS PLEASE

PCB & SCHEMATIC CAD

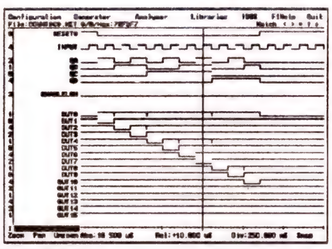
EASY-PC **£98**



- **Design Single sided, Double sided and Multilayer boards.**
- **Provides Surface Mount support.**
- **Standard output includes Dot Matrix / Laser / Inkjet printers, Pen Plotters, Photo-plotters and NC Drill.**
- **Award Winning EASY-PC is in use in over 9000 installations in 50 Countries World-Wide.**
- **Runs on PC/XT/AT/286/386 with Herc, CGA, EGA, VGA.**
- **Superbly Easy to use.**
- **Not Copy Protected.**

DIGITAL SIMULATION

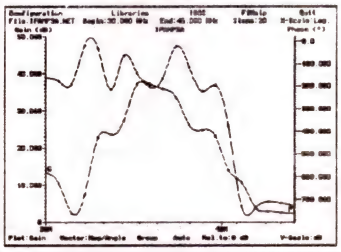
PULSAR **£195**



- **At last! A full featured Digital Circuit Simulator for less than £1000!**
- **Pulsar allows you to test your logic designs without the need for expensive test equipment.**
- **Catch glitches down to a pico second per week!**
- **Includes 4000 Series CMOS and 74LS Libraries.**
- **Runs on PC/XT/AT/286/386/486 with EGA or VGA. Hard disk recommended.**
- **Not Copy protected.**

ANALOGUE SIMULATION

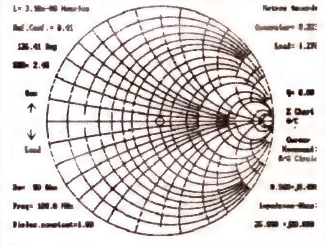
ANALYSER III **£195**



- **NEW powerful ANALYSER III has full graphical output.**
- **Handles R's, L's, C's, BJT's, FET's, OP-amp's, Tapped and untapped Transformers, and Microstrip and Co-axial Transmission Lines.**
- **Calculates Input and Output Impedances, Gain and Group Delay.**
- **Covers 0.001 Hz to >10GHz**
- **Runs on PC/XT/AT/286/386/486 with EGA or VGA.**
- **Not Copy protected.**

SMITH CHART CAD

Z-MATCH II **£195**



- **Z-MATCH II takes the drudgery out of RF matching problems and includes many more features than the standard Smith Chart.**
- **Provides quick accurate solutions to many matching problems using transmission line transformers, stubs, discrete components etc.etc..**
- **Supplied with comprehensive user instructions including many worked examples.**
- **Runs on PC/XT/AT/386/486, CGA,EGA,VGA**
- **Not Copy Potected**

For full information please Phone, Fax or Write.

Number One Systems Ltd.
The Electronics CAD Specialists

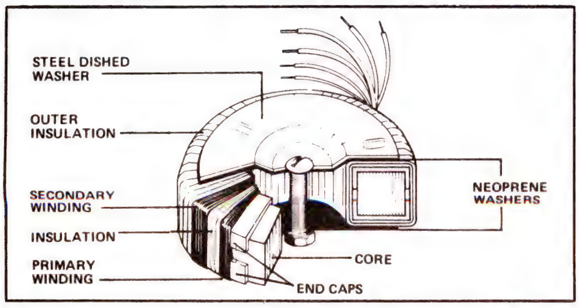
See us at Desk-Top CAD Stand 137, 5-7 Nov.

REF: EVD, HARDING WAY, SOMERSHAM ROAD, ST.IVES, HUNTINGDON, CAMBS, PE17 4WR, ENGLAND.
Telephone: 0480 61778 (7 lines) Fax: 0480 494042 International: +44-480-61778 Fax: +44-480-494042
ACCESS, AMEX, MASTERCARD, VISA Welcome.

OLP TRANSFORMERS FROM JAYTEE

The UK Distributor for Standard Toroidal Transformers

* 106 types available from stock
* Sizes from 15VA to 625VA



Write or phone for free Data Pack

Jaytee Electronic Services
143 Reculver Road, Beltinge, Herne Bay, Kent CT6 6PL
Telephone: (0227) 375254

Carbon Film resistors ¼W 5% E24 series 0.51 R to 10MO	1p
100 off per value – 75p. even hundreds per value totalling 1000	£6.00p
Metal Film resistors ¼W 10R to 1 MO 5% E12 series – 2p. 1% E24 series	3p
Mixed metal/carbon film resistors ½W E24 series 1RO to 10MO	1½p
1 watt mixed metal/Carbon Film 5% E12 series 4R7 to 10 Megohms	5p
Linear Carbon pre-sets 100mW and ¼W 100R to 4M7 E6 series	7p
Miniature polyster capacitors 250V working for vertical mounting	
.015, .022, .033, .047, .068-4p. 0.1 - 5p. 0.12, 0.15, 0.22 - 6p. 0.47 - 8p. 0.68 - 8p. 1.0 - 12p	
Mylar (polyester) capacitors 100V working E12 series vertical mounting	
1000p to 8200p - 3p. .01 to .068 - 4p. 0.1 - 5p. 0.12, 0.15, 0.22 - 6p. 0.47/50V - 8p	
Submin ceramic plate capacitors 100V wkg vertical mountings. E12 series	
2% 1.8pf to 47pf - 3p. 2% 56pf to 330pf - 4p. 10% 390p-4700p	4p
Disc/plate ceramics 50V E12 series 1PO to 1000P, E6 Series 1500P to 47000P	2p
Polystyrene capacitors 63V working E12 series long axial wires	
10pf to 820pf - 4p. 1000pf to 10,000pf - 5p. 12,000pf	6p
741 Op Amp - 20p. 555 Timer	22p
cmos 4001 - 20p. 4011 - 22p. 4017	40p
ALUMINIUM ELECTROLYTICS (Mfds/Volts)	
1/50, 2.2/50, 4.7/50, 10/25, 10/50	5p
22/16, 22/25, 22/50, 47/16, 47/25, 47/50	6p
100/16, 100/25 7p; 100/50 12p; 100/100	14p
220/16 8p; 220/25, 220/50 10p; 470/16. 470/25	11p
1000/25 25p; 1000/35, 2200/25 35p; 4700/25	70p
Submin, tantalum bead electrolyics (Mfds/Volts)	
0.1/35, 0.22/35, 0.47/35, 1.0/35, 3.3/16. 4.7/16	14p
2.2/35, 4.7/25, 4.7/35, 6.8/16 15p; 10/16, 22/6	20p
33/10, 47/6, 22/16 30p; 47/10 35p; 47/16 60p; 47/35	80p
VOLTAGE REGULATORS	
1A + or − 5V, 8V, 12V, 15V, 18V & 24V - 55p. 100mA. 5.8, 12, 15, V +	30p
DIODES (piv/amps)	
75/25mA 1N4148 2p. 800/1A 1N4006 4½p. 400/3A 1N5404 14p. 115/15mA OA91	8p
100/1A 1N4002 3½p. 1000/1A 1N4007 5p. 60/1.5A S1M1 5p. 100/1A bridge	25p
400/1A 1N4004 4p. 1250/1A BY 127 10p. 30/15A OA47	10p
Zener diodes E24 series 3V3 to 33V 400mW - 8p. 1 watt	12p
Battery snaps for PP3 - 6p for PP9	12p
L.E.D.'s 3mm. & 5mm. Red, Green, Yellow - 10p. Grommets 3mm - 2p. 5mm	2p
Red flashing L.E.D.'s require 9-12V supply only	50p
Mains indicator neons with 220k resistor	10p
20mm fuses 100mA to 5A. O. blow 5p.A/surge 10p. Holders, chassis, mounting	6p
High speed pc drill 0.8, 1.0, 1.3, 1.5, 2.0mm - 30p. Machines 12V dc	£7.00
HELPING HANDS 6 ball joints and 2 croc clips to hold awkward jobs	£3.50p
AA/HP7 Nicad rechargeable cells 90p each. Universal charger unit	£6.50p
Glass reed switches with single pole make contacts - 8p. Magnets	12p
0.1" Stripboard 2½" x 1" 9 rows 25 holes - 25p. 3¾ x 2½" 24 rows 37 holes	70p
Jack plugs 2.5 & 3.5m	14p
Sockets Panel Mtg. 2.5 & 3.5m	10p
TRANSISTORS	
BC107/8/9 - 12p. BC547/8/9 - 8p. BC557/8/9 - 8p. BC182, 182L, BC183, 183L, BC184, 184L, BC212, 212L - 10p.	
BC327, 337, 337L - 12p. BC727, 737 - 12p. BD135/6/7/8/9 - 25p. BCY70 - 15p. BFY50/51/52 - 20p.	
BFX88 - 15p, 2N3055 - 50p, TIP31, 32 - 30p, TIP41, 42 - 40p. BU208A - £1.20, BF195, 197 - 12p	
Ionisers with seven year guarantee, list price £16.95	£12.00

All prices are inclusive of VAT. Postage 30p (free over £5). Lists Free.

THE CR SUPPLY CO
127 Chesterfield Rd., Sheffield S8 0RN
Tel: 0742 557771 *Return posting*

EVERYDAY ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

ABC

The No 1 Magazine for Electronic & Computer Projects

JANUARY 1991 TO DECEMBER 1991

Pages	*Issue*	*Pages*	*Issue*
1-72	January	409-472	July
73-144	February	473-536	August
145-216	March	537-608	September
217-280	April	609-680	October
281-344	May	681-752	November
345-408	June	753-832	December

VOLUME 20 INDEX

CONSTRUCTIONAL PROJECTS

ALARM, BASIC 176
ALARM, BICYCLE 692
ALARM, FISH BITE 370
ALARM, PERSONAL 189
ALARM REPEATER, SMOKE 310
ALARM, VIBRATION 182
ALPHA RELAXATION MACHINE 548, 782
AMATEUR BAND RADIO, 80M 108
AMPLIFIER/SIGNAL TRACER, BENCH 118
AMSTRAD PCW SOUND GENERATOR *by Jason Sharpe* 42
ANALOGIC TEST PROBE *by Mark Stuart* 16
AUDIO OUTPUT DISPLAY, L.E.D. 25
AUTOMATIC LIGHT CONTROL *by Mungo Henning* 364
AUTO NIGHTLIGHT *by Alan Winstanley* 800

BASIC ALARM *by Max Horsey* 176
BATTERY RECHARGER, DRY CELL 552
BATTERY-TO-MAINS INVERTER *by Mark Daniels* 156
BATTERY VOLTAGE MONITOR, CAR 92
BENCH AMPLIFIER/SIGNAL TRACER *by Mike Tooley* 118
BETA RELAXATION MACHINE 548, 782
BICYCLE ALARM *by Max Horsey* 692
BIOFEEDBACK MACHINE 548
BITE ALARM, FISH 370
BLANKET SHUTDOWN, ELECTRIC 128
BRAINWAVE *by Andy Flind* 548

CAMERA RELEASE, REMOTE 738
CAPACITANCE METER *by Steve Knight* 570
CAR BATTERY VOLTAGE MONITOR 92
CAR CODE LOCK *by Mark Stuart* 184
CAROUSEL, MODEL MUSICAL 503
CAR TACHOMETER, DIGITAL/ANALOGUE 356
CAT FLAP, ELECTRONIC 244
CENTURION TANK 643
CHARGER, DRY CELL 552
CHARGER, 12V NiCad 454
CHASER LIGHTS MODULE 390
CHRISTMAS DECORATION 791
COMBINATION LOCK, CAR 184
COMMUNICATIONS LINK, OPTICAL 484
CONTROL SYSTEM, MAINS APPLIANCE REMOTE 84
CONTROLLER, MODEL TRAIN 228

DARTS SCORER *by Richard Stone* 697
DELTA RELAXATION MACHINE 548, 782
DIE, ELECTRONIC 268
DIGILOGUE CAR TACHOMETER *by Chris Walker* 356
DIGITAL LCD THERMOSTAT *by Mark Stuart* 292
DIGITAL LOCK 184
DIMMER, 12V LAMP 566
DISCO LIGHTING SYSTEM 298, 390, 464, 522, 593, 661, 728
DISCO LIGHTS CONTROLLER *by Mike Tooley* 429
DOLL'S HOUSE, MODEL 584
DRY CELL RECHARGER *by Alan Tong* 552
ELECTRIC BLANKET SHUTDOWN *by T. R. de Vaux-Balbirnie* 128
ELECTRONIC CAT FLAP *by Robert Penfold* 244
ELECTRONIC DARTS SCORER 697
ELECTRONIC DIE *by Mike Tooley* 268
ENTRAINMENT MACHINE 548, 782
EXPOSURE UNIT, ULTRA-VIOLET 628

FISH BITE INFRALARM *by Jonathan Living* 370

GENERATOR, AMSTRAD PCW SOUND 42
GENERATOR, PULSE 330
GENERATOR, WAVEFORM 162, 764
GINGERNUT 80m AMATEUR BAND RECEIVER *by Bill Mooney* 108
GUITAR TREMOLO 250

HOME SMOKE ALARM REPEATER 310
HUMIDITY TESTER *by Edward Barrow* 234

INDICATOR, PERSONAL STEREO POWER 313
INFRALARM, FISH BITE 370
INFRA RED AUDIO COMMUNICATIONS LINK 484
INFRA RED REPEATER, PASSIVE 316
INTERCOM, SIMPLE 12
INTERFACE, PC-SCOPE 620
INVERTER, BATTERY-TO-MAINS 156

KNOCKERBOX *by David Smith* 814

LAMP DIMMER, 12V 566
L.E.D. AUDIO OUTPUT POWER DISPLAY 25
LIGHT ACTIVATED MAINS SWITCH 364
LIGHT CONTROL, AUTOMATIC 364
LIGHTS CONTROLLER, DISCO 429
LIGHTS CONTROLLER, MODULAR DISCO 298, 390, 464, 522, 593, 611, 728
LINK, OPTICAL COMMUNICATIONS 484
LOCK, CAR CODE 184
LOGIC TEST PROBE 16

MAINS APPLIANCE REMOTE CONTROL SYSTEM *by Chris Walker* 84
MAINS SWITCH, PRESSURE/LIGHT ACTIVATED 363
MASTERLINK MODULE 464
METER CAPACITANCE 570
METER, ULTRASONIC PROXIMITY 420
MIND MACHINE *by Andy Flind* 782
MINI-MICROWAVE 716
MODEL SERIES, SIMPLE 493, 503, 584, 643, 716, 791
MODEL TRAIN CONTROLLER *by Chris Bowes* 228
MODULAR DISCO LIGHTING SYSTEM *by Chris Bowes* 298, 390, 464, 522, 593, 661, 728
MUSICAL ROUNDABOUT, MODEL 503

NiCad CHARGER, 12V 454
NIGHTLIGHT, AUTO 800

OPTICAL COMMUNICATIONS LINK *by Mike Tooley* 484

PASSIVE INFRA-RED REPEATER *by T. R. de Vaux-Balbirnie* 316
PC-SCOPE INTERFACE *by John Becker* 620
PEDOMETER *by R. M. Worthington* 498
PERSONAL ALARM *by T. R. de Vaux-Balbirnie* 189
PERSONAL STEREO POWER INDICATOR *by T. R. de Vaux-Balbirnie* 313
PEsT SCARER, PORTABLE ULTRASONIC 490
POCKET TONE DIALLER *by Chris Walker* 198
POLARITY CHECKER *by C. H. Greaves* 582
POLICE CAR, SIMPLE MODEL 439
PORTABLE ULTRASONIC PEsT SCARER *by Mark Stuart* 490
POWER INDICATOR, PERSONAL STEREO 313
PREAMPLIFIER, RIAA 638
PRESSURE MAT MAINS SWITCH 364
PRINTED CIRCUIT BOARD EXPOSURE LIGHT 628
PROXIMITY METER, ULTRASONIC 420
PULSE GENERATOR *by Mike Tooley* 330

RADIO RECEIVER *by Mike Tooley* 384
RADIO, 80M AMATEUR BAND 108
RANDOM PATTERN MODULE 522
RECHARGER, DRY CELL 552
RELAXATION MACHINE 548, 782
REMOTE CAMERA RELEASE *by T. R. de Vaux-Balbirnie* 738
REMOTE CONTROL SYSTEM, MAINS APPLIANCE 84
REPEATER, PASSIVE IR 316
REPEATER, SMOKE ALARM 310
RIAA PREAMPLIFIER *by Robert Penfold* 638
ROUNDABOUT, MUSICAL MODEL 503

SCORER, DARTS 697
SIGNAL GENERATOR *by Steve Knight* 764
SIGNAL TRACER, BENCH AMPLIFIER/ 118
SIMPLE INTERCOM *by Mike Tooley* 12

- SIMPLE MODEL SERIES
  - *by Owen Bishop* 439, 503, 584, 643, 716, 791
  - Centurion Tank 643
  - Christmas Decoration 791
  - Doll's House Micro 584
  - Mini-Microwave 716
  - Musical Roundabout 503
  - Polic Car 439
- SINE WAVEFORM GENERATOR 162, 764
- SMOKE ALARM REPEATER *by T. R. de Vaux-Balbirnie* 310
- SOUND GENERATOR, AMSTRAD PCW 42
- SOUND OPERATED SWITCH *by Owen Bishop* 54
- SPATIAL POWER DISPLAY *by Gary Calland* 25
- SQUARE WAVEFORM GENERATOR 162, 764
- SUPERCHASER 728
- SUPERSWEEP 728
- SURFACE-MOUNT 80m AMATEUR BAND RECEIVER 108
- SWEEPER MODULE, LIGHTS 390
- SWITCH, SOUND OPERATED 54
- SWITCHED POWER OUTPUT MODULE 298

- TACHOMETER, DIGILOGUE CAR 356
- TEACH-IN PROJECTS
  - *by Mike Tooley* 12, 118, 162, 268, 330, 384, 429, 484
  - Bench Amplifier/Signal Tracer 118
  - Die, Electronic 268
  - Disco, Lights Controller 429
  - Intercom, Simple 12
  - Optical Communications Link 484
  - Pulse Generator 330
  - Radio Receiver 384
  - Waveform Generator 162
- TELEPHONE TONE DIALLER 198
- TELEPHONE WAILER *by T. R. de Vaux-Balbirnie* 179
- TESTER, HUMIDITY 234
- TESTER, POLARITY 582
- THERMOSTAT, DIGITAL LCD 292
- THETA RELAXATION MACHINE 548, 782
- THREE TRANSISTOR TREMOLO *by M. G. Argent* 250
- TRAIN CONTROLLER, MODEL 228
- TREMOLO, THREE TRANSISTOR 250
- TRF RADIO RECEIVER 384
- TRIANGLE WAVEFORM GENERATOR 162, 764

- ULTRASONIC PEsT SCARER, PORTABLE 490
- ULTRASONIC PROXIMITY METER *by Chris Walker* 420
- ULTRASONIC REMOTE CAMERA RELEASE 738
- UV EXPOSURE UNIT *by R. M. Worthington* 628

- VEHICLE VOLTAGE MONITOR *by Steve Garrison* 92
- VIBRATION ALARM *by Paul Benton* 182
- VU MODULE 661

- WAILER, TELEPHONE 179
- WAVEFORM GENERATOR *by Mike Tooley* 162
- WAVEFORM GENERATOR 764
- WALKING DISTANCE INDICATOR 498

- 12V d.c. TO 240V a.c. INVERTER 156
- 12V FLUORESCENT LIGHTING TUBE DRIVER 628
- 12V LAMP DIMMER *by T. R. de Vaux-Balbirnie* 566
- 12V NiCad CHARGER *by T. R. de Vaux-Balbirnie* 454
- 80m AMATEUR BAND RECEIVER 108

SPECIAL SERIES

- ACTUALLY DOING IT
  - *by Robert Penfold* 57, 106, 196, 240, 590, 668, 774
- AMATEUR RADIO *by Tony Smith G4FA1*
  - 60, 114, 201, 249, 336, 463, 520, 592, 660, 714, 812

- DESIGN YOUR OWN CIRCUITS (TEACH-IN '91)
  - *by Mike Tooley* 33, 96, 168, 252, 322, 376, 446, 514, 558
  - 2 - Small Signal Amplifiers 33
  - 3 - Power Amplifiers 96
  - 4 - Oscillators 168
  - 5 - Logic Circuits 252
  - 6 - Timers 322
  - 7 - Radio Circuits 376
  - 8 - Power Control 446
  - 9 - Opto-Electronics 514
  - 10 - Layout, Construction and Assembly Techniques and Assessment Test 558

- GCSE PROJECT DEVELOPMENT 20, 124, 202, 238, 320, 362

- INFORMATION TECHNOLOGY AND THE NATIONAL CURRICULUM *by T. R. de Vaux-Balbirnie* 708, 806
  - 1 - Basic Communication 708
  - 2 - The Electric Telegraph 806

- INTERFACE *by Robert Penfold*
  - 49, 126, 266, 334, 368, 436, 512, 556, 652, 736, 804

- MAGNETIC RECORDING *by Vivian Capel* 633, 722, 796
  - 1 - What is Magnetism? Why Use Bias 633
  - 2 - Recording and Playback Heads 722
  - 3 - Head Maintenance and Adjustment 796

- PROJECT DEVELOPMENT FOR GCSE
  - 20, 124, 202, 238, 320, 362
  - 1 - Introduction 20
  - 2 - Choosing Your Project, Elderly Person's Alarm 124
  - 3 - Developing Your Circuit, Improving the Alarm Circuit 202
  - 4 - Planning Your Construction Method 238
  - 5 - Soldering-up and Boxing-up 320
  - 6 - Last-minute Hitches – What to do 362

- SIMPLE MODEL SERIES
  - *by Owen Bishop* 439, 503, 584, 643, 716, 791

- TEACH-IN '91 (Design Your Own Circuits)
  - 33, 96, 168, 252, 322, 376, 446, 514, 558

- ROBOT ROUNDUP *by Nigel Clark*
  - 52, 117, 204, 329, 400, 458, 501, 599, 657, 744, 818

GENERAL FEATURES

- A. C. CAPACITORS *by B. Cordingley* 396

- BETTER USE OF DRY CELLS *by Alan Tong* 494
- BLACKBUTTON BLUES *by Tony Hopwood* 272
- BLUMLEIN *by Barry Fox* 576

- CAREERS IN ELECTRONICS *by James Robertson* 192

- DOWN TO EARTH
  - *by George Hylton* 62, 132, 526, 574, 654, 726, 779

- EDITORIAL
  - 11, 83, 155, 227, 291, 355, 419, 483, 547, 619, 691, 763

- FOR YOUR ENTERTAINMENT
  - *by Barry Fox* 32, 123, 160, 233, 309, 452, 489, 650, 776
- FROM FISH TO CHIPS *by James Fowkes* 426

- MILITARY ELECTRONICS *by Pete Chown* 22

- PIP ROBOT REVIEW *by A. Pickard* 262

- SHOPTALK
  - *by David Barrington* 46, 133, 166, 241, 335, 394, 428, 488, 591, 651, 724, 780

- WIND YOUR OWN TRANSFORMERS *by Peter Roberts* 304

SPECIAL OFFERS AND SERVICES

- BOOK SERVICE
  - 64, 134, 206, 273, 337, 401, 528, 600, 745, 820

- COMPONENTS CATALOGUE
  - (Bull '91 Mail Order) between 36/37
- COMPONENTS CATALOGUE
  - (32-page Greenweld Spring '91) between 248/249
- COMPONENTS CATALOGUE
  - (16-page Greenweld Summer Sale) between 504/505
- COMPONENTS CATALOGUE
  - (132-page Greenweld '92) banded with NOV '91
- COMPONENTS CATALOGUE
  - (48-page Greenweld Bargain List) between 792/793
- COMPONENTS CATALOGUE
  - (32-page Marco Spring '91) between 180/181
- COMPONENTS CATALOGUE
  - (132-page Marco '92) banded with OCT '91

- EASIWIRE (Simple Model Series Special Offer)
  - Centurion Tank 642, Christmas Decoration 790; Doll's House Micro 589; Mini-Microwave 721; Musical Roundabout 502; Police Car 438

- MARKET PLACE 29, 122

- PRINTED CIRCUIT BOARD SERVICE
  - 68, 138, 210, 276, 344, 404, 468, 532, 604, 674, 748, 824

EVERYDAY ELECTRONICS CLASSIFIED

The prepaid rate for semi-display space is £8 (+VAT) per single column centimetre (minimum 2.5cm). The prepaid rate for classified adverts is 30p (+VAT) per word (minimum 12 words).

All cheques, postal orders, etc., to be made payable to Everyday Electronics. **VAT must be added.** Advertisements, together with remittance, should be sent to the Classified Advertisement Dept., Everyday Electronics, 6 Church Street, Wimborne, Dorset BH21 1JH. Tel: (0202) 881749.

SERVICE MANUALS

Available for most Video Recorders, Colour & Mono Televisions, Cameras, Test Equipment, Amateur Radio, Vintage Valve Wireless, Any Audio, Music Systems, Computers, Kitchen Appliances, etc.

Equipment from the 1930's to the present.

Over 100,000 models stocked, originals & photostats.

FREE Catalogue Repair & Data Guides with all orders

MAURITRON TECHNICAL SERVICES (EE)

8 Cherry Tree Road, Chinnor,
Oxfordshire OX9 4QY
Tel: (0844) 51694
Fax: (0844) 52554

BTEC ELECTRONICS TECHNICIAN FULL-TIME TRAINING

THOSE ELIGIBLE CAN APPLY FOR E.T. GRANT SUPPORT
AN EQUAL OPPORTUNITIES PROGRAMME

O.N.C., O.N.D. and H.N.C.

Next course commences
Monday 6th January 1992
FULL PROSPECTUS FROM

LONDON ELECTRONICS COLLEGE
(Dept EE) 20 PENYWERN ROAD
EARLS COURT. LONDON SW5 9SU
TEL: 071-373 8721

PCB CAD USERS

Artwork transparencies produced from your printouts or files
Superb quality
SAE for details and FREE sample

SB Electronics Services
10 Peacock Crescent
Clifton Estate, Nottingham NG11 8EP
Tel 0602 841831

UCANDO ELECTRONICS TRAINING BY VIDEO

Learn Electronics by Video lessons.

DC/AC Power supplies, Semiconductors, Amplifiers, Oscillators, plus 2 videos for VCR Maintenance & Repair.

Plus Teaching Kitsets.

For all countries using PAL & NTSC English language instruction.

Worldwide distribution for PAL & NTSC format.

Mastercard and Visa accepted.

ELECTRONICS ASSEMBLY COMPANY

P.O. Box 21191, Christchurch
New Zealand
Phone: 3-795-570

ON-LINE VIDEO

ELECTRONICS FOR THE HOBBYIST is a 90 minute video-cassette using computer-graphic simulations to enable the hobbyist or student to understand the way in which common electronic components work and is available directly from us at only £19.95 inc. P&P.

Other titles available. S.A.E. for list. Allow 14 days for delivery. Send Cheques/P.O. payable to:

On-Line Video Marketing (Dept EV-2)
The Cottage, Tredown Farm, Bradstone,
Milton Abbot, Tavistock, Devon PL19 0QT

RCS VARIABLE VOLTAGE D.C. BENCH POWER SUPPLY

1 to 24 volts up to ½ amp. 1 to 20 volts up to 1 amp. 1 to 16 volts up to 1½ amps d.c. Fully stabilised. Twin panel meters for instant voltage and current readings. Overload protection

Fully variable.
Operates from 240V a.c.
Compact Unit.
Size 9 x 5½ x 3in.

£45 inc. VAT
+ Post and insurance £4

NEW MODEL. Up to 38volts d.c. at 6 amps. 10 amps peak. Fully variable. Twin panel meters. Size 14½ x 11 x 4½in. £96 inc VAT. Carr £6.

RADIO COMPONENT SPECIALISTS

337 WHITEHORSE ROAD, CROYDON
SURREY, U.K. Tel: 081-684 1665

List, Large SAE. Delivery 7 days. Callers welcome. Closed Wednesday

£££ SAVERS/FANCY BITS & FREEBIES

For him, her, and the kids for Xmas. Plus psu's from £1.25. Fairy lights £2.25/£2.75 and more. PLUS free clearance lists with a free bonus gift by instant return.

BAEC members welcome. SAE to:

C. Bibby, 2 Moorcroft Road
Northern Moor, Wythenshawe
Manchester M23 0WJ

NEW VHF MICROTRANSMITTER KIT

Tuneable 80-135MHz, 500 metre range, sensitive electret microphone, high quality PCB.

SPECIAL OFFER complete kit ONLY £5.95
Assembled and ready to use £9.95 post free.

Access/Visa orders telephone 021 411 1821

Send 2x1st class stamps for Catalogue. Cheques/P.O.s payable to:

QUANTEK ELECTRONICS LTD
Kits Dept. (EE), 45a Station Road
Northfield, Birmingham B31 3TE

Rechargable Batteries

Quantity	1-99	100-499
AA (HP7) 500mAH	£0.99	£0.77+VAT
AA 500mAH solder tags	£1.55	£0.95+VAT
AA 700mAH high capacity	£1.95	£1.20+VAT
C (HP11), 1.2AH	£2.20	£1.69+VAT
C 2AH with solder tags	£3.60	£2.25+VAT
D (HP2) 1.2AH	£2.60	£1.96+VAT
D 4AH with solder tags	£4.95	£3.59+VAT
PP3 8.4V 110mAH	£4.95	£3.85+VAT
Sub C with solder tags 1.2AH	£2.50	£1.70+VAT
1/2 AA with solder tags	£1.55	£1.17+VAT
AAA (HP16) 180mAH	£1.75	£1.15+VAT

Special offers for unusual sizes only while stocks last. Please check availability before ordering.

Quantity	1-99	100-499
F cell 7AH 32 x 87mm with flat top	£3.95	£2.80+VAT
F cell with solder tags	£4.30	£3.00+VAT
Cellular telephone battery 42mm long x 16mm dia	£1.45	£0.95+VAT
Stick of 4 171 x 16 dia with 150mm red & black leads	£5.95	£4.00+VAT
4 cell battery 94 x 25mm 4.8V	£3.50	£2.30+VAT

All 1 to 99 prices include VAT
Please add 95p postage & packing per order

JPG Electronics

276-278 Chatsworth Road, Chesterfield S40 2BH
Access & Visa orders tel: (0246) 211202

N. R. BARDWELL LTD (EE)

200	Signal diodes 1N4148	£1.00
75	Rectifier Diodes 1N4001	£1.00
75	Rectifier Diodes 1N4003	£1.00
50	Rectifier Diodes 1N4007	£1.00
56	Rectifier Diodes 1N5401	£1.00
10	NE555 Timer i.c.s	£1.00
5	741 Op Amp i.c.s	£1.00
8	C106D1 400V 6 amp thyristors	£1.00
8	BFY51 Transistors	£1.00
30	BC478 Transistors	£1.00
30	MPSA92 Transistors	£1.00
25	Asstd. high brightness l.e.d.s	£1.00
50	Axial l.e.d.s (Diode package) wide angle red	£1.00
50	Rectangular red l.e.d.s	£1.00
20	Miniature axial l.e.d.s super bright red	£1.00
24	Miniature red l.e.d.s 3mm dia	£1.00
12	Asstd. seven segment displays	£1.00
4	.43" Com. anode seven segment displays	£1.00
100	22NF 100V radial film capacitors	£1.00
100	33NF 50V radial film capacitors	£1.00
200	Asstd. disc ceramic capacitors	£1.00
80	4U7 16V Radial electrolytics	£1.00
75	4U7 63V Radial electrolytics	£1.00
80	10UF 16V Radial electrolytics	£1.00
50	10UF 50V Radial electrolytics	£1.00
80	22UF 25V Radial electrolytics	£1.00
60	33UF 16V Radial electrolytics	£1.00
80	47UF 16V Radial electrolytics	£1.00
50	47UF 50V Radial electrolytics	£1.00
80	100UF 10V Radial eletrolytics	£1.00
50	220UF 16V Radial electrolytics	£1.00
60	470UF 10V Radial electrolytics	£1.00
40	1000UF 10V Radial electrolytics	£1.00
30	Asstd. IF transformers	£1.00
48	Asstd. coil formers	£1.00
100	Asstd. RF chokes	£1.00
30	Asstd. dil sockets up to 40 pin	£1.00
30	Assorted socket/conns/edge-dil-sil-etc	£1.00
20	1 inch Glass reed switches	£1.00
10	4P 3W MBB min. rotary switches	£1.00
20	Min SP/CO slide switches	£1.00
20	Magnetic ear pips plus lead & plug	£1.00
1	Peltier effect heat pump	£1.95
1	10 watt Stereo amplifier, 4 controls plus data	£2.95
1	10mm Flashing l.e.d. red	£0.75
1	10mm Ultra bright l.e.d. red 300 MCD	£0.60

Prices include VAT, postage £1.00. Stamp for Lists

288 Abbeydale Road, Sheffield S7 1FL
Phone (0742) 552886. Fax (0742) 500689

Fuselodge Ltd.

267 Acton Lane
Chiswick, London W4 5DD

Telephone/Fax
081-994 6275

We stock a large range of Electronic components, semiconductors, switches, resistors, capacitors, transformers, fans, cables, leads, boxes, tools, etc. Power supplies, test equipment. Custom made S.M. power supplies.

Mail order & Credit Cards accepted

Cooke International

We stock used test equipment, scopes, sig. gens., DVM's, oscillators, etc in large quantities.

We can now offer a copy service for workshop manuals for many instruments. Please ask for details. Send SAE for lists

Contact: Cooke International, Unit 4,
Fordingbridge Site, Main Road, Barnham,
Bognor Regis, West Sussex PO22 0EB

Open: Mon-Fri 9am-5pm or phone
0243 545111 - Fax: 0243 542457

Miscellaneous

KITS, PLANS, ETC for surveillance, protection (sonic, HV), "007" gear. Send 2 x 22p stamps for list. ACE(EE), 53 Woodland Way, Burntwood, Staffs.

G.C.S.E. ELECTRONICS KITS at pocket money prices. S.A.E. for FREE catalogue. SIR-KIT ELECTRONICS, 70 Oxford Road, Clacton CO15 3TE.

PROTOTYPE PRINTED CIRCUIT BOARDS one offs and quantities, for details send s.a.e. to B.M.A. Circuits, 38 Poynings Drive, Sussex BN3 8GR, or phone Brighton 720203.

SPY BOOKS. Interested in espionage, counter-surveillance, personal freedom or investigation? Do you seek information that some people feel should remain a secret or unpublished? Send large SAE to PO Box 2072, London NW10 0NZ.

CHRISTMAS/NEW YEAR – Something novel and fascinating. Nine 4in chemiluminescent lightsticks sent for £9.99. Lilco Ltd, 23 Middlewood Park, Livingston EH54 8AZ.

COLLECTORS! First 11 issues of Everyday Electronics from November 1971. Offers invited. Telephone 0745 591863.

286 AT SYSTEM Running at 16MHz, 5¼ and 3½in hd disc drive. 40Mb hard drive, mono monitor, 1Mb memory with software, £650. Write to Lee Yeung, 140 New Road, Skewen, Neath, W. Glam SA10 6HC.

MONEY FROM BUGS booklet of circuits and information on making and selling bugs and accessories £10.95 system. PO Box 1041, Misterton, Doncaster DN10 4BQ.

PE MOSCODE AMP KIT 100W/CH of superb sound. Easily built, only £189+ £5 postage. Details SAE to Hobtek, The Cottage, 8 Bartholomews, Brighton BN1 1HG

MAKE YOUR INTERESTS PAY!

Over the past 100 years more than 9 million students throughout the world have found it worth their while! An ICS home-study course can help you get a better job, make more money and have more fun out of life! ICS has over 90 years experience in home-study courses and is the largest correspondence school in the world. You learn at your own pace, when and where you want under the guidance of expert 'personal' tutors. Find out how we can help YOU. Post or phone today for your **FREE INFORMATION PACK** on the course of your choice. (Tick one box only!)

Electronics	☐	TV, Video & Hi-Fi Servicing	☐
Basic Electronic Engineering (City & Guilds)	☐	Refrigeration & Air Conditioning	☐
Electrial Engineering	☐	Car Mechanics	☐
Electrical Contracting/ Installation	☐	Computer Programming	☐
GCSE/GCE/SCE over 40 examination subjects to choose from			☐

Name ______________________ Address ______________________

ICS

International Correspondence Schools Dept ECS C1
Telephone 081-643 9568 or 041-221 2926 (24 hours)
312/314 High Street, Sutton, Surrey SM1 1PR.

Technical Information Services

76 CHURCH STREET, LARKHALL, LANARKSHIRE, ML9 1HE
Tel. (0698) 884585 Mon-Fri 8.30am - 5.00pm
Tel. (0698) 883334 Outwith business hours
FAX facility available all day on both lines
Write now with an SAE for your
FREE QUOTE FREE VOUCHERS & FREE CATALOGUE

VISA

Remember, not only do we have EVERY service sheet ever produced, but we also have

THE WORLDS LARGEST COLLECTION OF

SERVICE MANUALS

& WE ARE SOLE SUPPLIERS OF VARIOUS FAULT-FINDING GUIDES
REPAIR MANUALS & TECHNICAL MANUALS

CTV, Video, CD, Hi-Fi, Camcorder, Satellites, Computers, Domestic Equip', ..etc

DATA REFERENCE MANUAL ".....essential for the serious electrician"
FREE updating and a 10% discount voucher only £5.95
Incorporates Unique Model Identification and Chassis Data

NATIONAL
COLLEGE OF
TECHNOLOGY

DISTANCE LEARNING COURSES

The National College of Technology offer a range of packaged learning short courses for study at home or in an industrial training environment which carry national BTEC awards. Study can commence at any time and at any level enabling you to create a study routine to fit around existing commitments. Courses on offer include:

Analogue Electronics
Digital Electronics
Fibre/Optoelectronics
Programmable Logic Controllers

Tutor support and BTEC certification are available as options with no travelling or college attendance required. These very popular courses which are ideal for vocational training contain workbooks, audio cassette lecturettes, PCB's, instruments, tools, components and leads as necessary to support the theoretical and practical training. Whether you are a newcomer to electronics or have some experience and simply need an update or certification, there is probably a distance learning course ready for you. Write or telephone for details to:

National College of Technology
NCT Ltd., PO Box 11
Wendover, Bucks
Tel: (0296) 624270

C_SIM Electronic Circuit Simulation & Analysis Software

C_SIM is a circuit analysis & simulation environment for small computers. You can check for loop stability, frequency response or distortions in circuits before actually building anything, leading to 'right first time' designs, and lower development costs. It features:

★ Easy to use graphical user interface.
★ Editor for creation and viewing of circuit descriptions and simulation results.
★ Graph plotting program to plot simulation results, up to 4 traces per graph, with full cursor measurement system.
★ Analogue circuit simulator utilising a subset of the industry standard SPICE 2 simulator language, handling all passive components, BJTs, diodes, dependent and independent sources, and performing DC, AC and transient analysis.
★ A preprocessor which handles subcircuit hierarchies and library files of subcircuits.

C_SIM is constantly undergoing development. Forthcoming updates include an expression evaluator for passing parameters to subcircuits, and defining component values by formulae, C_SIM is available for the ATARI ST, COMMODORE AMIGA, and IBM PCs and compatibles, and comes complete with a ring bound manual. The PC version requires 512Kb RAM minimum, the ATARI ST/AMIGA versions reqire 1Mb RAM and 1Mb disk minimum. All versions run with hard disk if present, and are not copy protected. The price is £59.95 incl. p&p for all platforms. The IBM version comes on both 3.5 and 5.25 inch floppies.

Order now by post direct from

Akula Systems, 49 Lisson Grove, Mutley, Plymouth PL4 7DL

using cheque or postal order. Allow up to 28 days for delivery. Inquiries welcome. Alternatively, order your **demonstration** for only £14.95 incl., part-redeemable when purchasing full system. This features a fully functional, but cut down system (limited number of nodes & parameters), with manual on disk and printed command summary.

AF WAVEFORM GENERATOR

KIT ONLY

£29.95

(£39.95 BUILT & TESTED)

The major drawback for the electronics enthusiast is the high cost of test gear. This is the first in a series of low cost instruments designed to make test gear more affordable to the enthusiast.

★ SINE/SQUARE/TRIANGLE
★ FREQUENCY RANGE 20Hz-18kHz
★ OUTPUT SIGNAL VOLTAGE 0-10V p-p
★ POWERED BY TWO PP3 BATTERIES (Not supplied)

Just add £1.50 P&P and send cash, cheque or P.O. to:-

KM ELECTRONICS

54 Moorside Road, Kirkheaton, Huddersfield HD5 0LP. Tel: (0484) 545914

VARIABLE VOLTAGE TRANSFORMERS

INPUT 220/240V AC 50/60
OUTPUT 0-260V

	Price	P&P
0.5KVA 2.5 amp max	**£29.00**	**£3.75**
		(£38.48 inc VAT)
1KVA 5 amp max	**£37.40**	**£4.25**
		(£48.94 inc VAT)
2KVA 10 amp max	**£54.00**	**£5.48**
		(£69.89 inc VAT)
3KVA 15 amp max	**£71.50**	**£6.24**
		(£91.34 inc VAT)
5KVA 25 amp max	**£126.50**	
	(Carriage on request)	

Buy direct from the Importers. Keenest prices in the country

COMPREHENSIVE RANGE OF TRANSFORMERS–LT–ISOLATION & AUTO
(110-240V Auto transfer either cased with American socket and mains lead or open frame type. Available for immediate delivery.

ULTRA VIOLET BLACK LIGHT FLOURESCENT TUBES

4ft 40 watt **£10.44** (callers only)	(£12.27 inc VAT)
2ft 20 watt **£7.44** + £1.25 p&p	(£10.21 inc VAT)
13in 10 watt **£5.80** + 75p p&p	(£7.70 inc VAT)
12in 8 watt **£4.80** + 75p p&p	(£6.52 inc VAT)
9in 6 watt **£3.96** + 50p p&p	(£5.24 inc VAT)
6in 4 watt **£3.96** + 50p p&p	(£5.24 inc VAT)

230V AC BALLAST KIT
For either 6in, 9in or 12in tubes **£5.50** + 55p p&p (£7.11 inc VAT)
For 13in tubes **£6.00** + 75p p&p (£7.93 inc VAT)

400 WATT UV LAMP
Only **£34.00** + £2.50 p&p £42.89 inc VAT)

175 WATT SELF BALLASTED BLACK LIGHT MERCURY BULBS
Available with BC or ES fitting. Price inc VAT & p&p **£20.27**

12 VOLT BILGE PUMPS

Buy direct from the importers.
500 GPH 15ft head 3 amp **£16.36**
1750 GPH 15ft head 9 amp **£26.65**
PRICES INCLUDE P&P & VAT

EPROM ERASURE KIT
Build you own **EPROM ERASURE** for a fraction of the price of a made-up unit kit of parts less case includes 12in 8 watt 2537 Angst Tube Ballast unit, pair of bi-pin leads, neon indicator, on/off switch, safety microswitch and circuit **£14.00** + £2.00 p&p (£18.80 inc VAT)

SUPER HY-LIGHT STROBE KIT
Designed for Disco, Theatrical use etc.
Approx 16 joules. Adjustable speed **£48.00** + £2.00 p&p (£58.75 inc VAT)
Case and reflector **£22.00** + £2.00 p&p (£28.20 inc VAT).
SAE for further details including Hy-Light and industrial Strobe Kits.

"BOFFINS SPECIAL" – UNIQUE OFFER

Surplus Precision Medical Unit, internally in excellent condition. Designed primarily to eject a precise controllable amount of fluid from a medical syringe (latter not supplied). Contains the following removable components: Dual Micro Processor Boards and EPROMS. Escap Precision 12V DC Motor with 300:1 Gear Box and optical encoder coupled to a precision threaded drive mechanism. Mains supply with 6 x 1.5V Ni-Cad A.A. cells back-up. L.C.D. Digital read-out 17mm high with legends. Audible warning.
These are sold for the dismantling of the exceptional quality components. Regret no Circuits available.
Ridiculously low price: **£16.00 + £4.00 p&p (£23.50 incl VAT).**

WIDE RANGE OF XENON FLASHTUBES
Write/Phone your enquiries

GIANT BLOWER EXTRACTOR UNIT
Twin output centrifugal blower 1 HP, 240V AC motor, output approx. 3800 c.f.m. Size: Length 100cm; height 27cm; Depth 26cm. Fixing plate 106 x 33cm. Price **£125** + VAT. Ex-warehouse.

TORIN CENTRIFUGAL BLOWER
230V AC, 2,800 RPM, 0.9 amp, 130mm diameter, impellor outlet 63 x 37mm, overall size 195 x 160 x 150mm. long. Price **£17.50** + £2.50 p&p (£23.50 inc. VAT)

SHADED POLE GEAR MOTORS
In the following sizes: 9RPM, 12 RMP, 80 RPM, 160 RPM. 110V AC or 240V AC with capacitors (supplied). Price inc VAT & p&p **£14.86**

GEARED MOTORS
71 RPM 20lb inch torque reversable 115V AC input including capacitor and transformer for 240V AC operation. Price inc VAT & p&p **£23.50**.

SOLID STATE EHT UNIT
Input 230/240V AC, Output approx 15KV. Producing 10mm spark. Built-in 10 sec timer. Easily modified for 20 sec, 30 sec to continuous. Designed for boiler ignition. Dozens of uses in the field of physics and electronics, eg supplying neon or argon tubes etc. Price less case **£8.50** + £1.00 p&p (£11.16 inc VAT) NMS

HEAVY DUTY MOTOR
Crouzet 115V/230V AC heavy duty 1RPM motor. Anticlockwise type 82/015. Size 68mm, diameter x 55mm long. Shaft 6mm diameter x 20mm long. Price inc VAT & p&p **£18.86**.

RHEOSTAT
50W 2 ohm 5 amp ceramic power rheostat. price inc VAT & p&p **£10.61**

MICROSWITCH
Pye 15 amp changeover lever microswitch, type S171. Brand new. price 5 for **£7.05** inc VAT & p&p

NMS = NEW MANUF SURPLUS
R&T = RECONDITIONED AND TESTED

SERVICE TRADING CO

57 BRIDGMAN ROAD, CHISWICK, LONDON W4 5BB
081-995 1560
ACCOUNT CUSTOMERS MIN. ORDER £10

Showroom open Monday/Friday

VISA
Ample Parking Space

19" RACK MOUNTING EQUIPMENT CASES

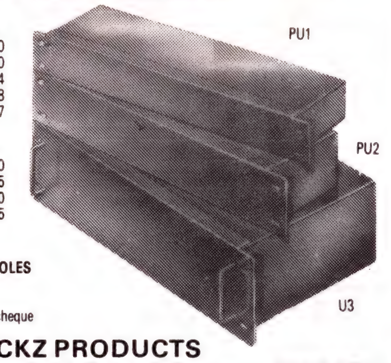
This range of 19" rack cases features satin black finished 16SWG (1.5mm) steel front panels (no fixing holes visible), with the rear box assembly constructed from 20SWG (.9mm) steel. The standard units are 10" (254mm) deep. 19" project cases only 4" (101mm) deep and are available in the following popular sizes:

PROJECT CASES

Type	Height	Price
PU1	1¾" (44mm)	£17.00
PU2	3½" (88mm)	£18.90
PU3	5¼" (133mm)	£20.94
PU4	7" (178mm)	£22.98
PU6	10½" (266mm)	£27.07

EQUIPMENT CASES

Type	Height	Price
U1	1¾" (44mm)	£21.50
U2	3½" (88mm)	£24.75
U3	5¼" (133mm)	£28.20
U4	7" (178mm)	£30.55



Delivery included (UK only).
All prices include VAT.
BLANKING PANELS, RACKING CONSOLES and **RACK CABINETS** are also available.
Please send **SAE** for details.
Tel: 0275 823983 for Access/Visa Sales or cheque with order to:

RACKZ PRODUCTS
PO Box 1402 Mangotsfield, Bristol, England, BS17 3RY

WE BUY MANUFACTURER'S SURPLUS STOCK HENCE THESE LOW PRICES FOR PRIME COMPONENTS

	PRICE
PAPST FAN - 12V DC 1W 80mm² 32mm deep	**£8.50**
ETRI FAN – 240V. 14W. – 120mm² 38mm deep	**£8.50**
RELAY - SIEMENS – 12V 2 pole c/o. Low Profile. Gold contact, high quality	**£1.00**
MAINS FILTER – Bulgin or similar 'quality' make/I.E.C./3A. 250V	**£1.80**
TORROID TRANSFORMER + complete wiring diag. – 240V in. Outputs 12V 4A, 12V 0.4A, 12-0-12 1A + 2A, 9-0-9 2A	**£4.00**
THERMAL PRINTER PAPER– Rolls 80mm wide 25m long	**£1.00**
Box of 40 rolls	**£23.00**
BARGAIN PACKS – Approx 3 lbs. of quality **NEW** mixed components. No rubbish! We deal mainly in bulk to the trade. All smaller qty. parts go in the packs regardless of value	**£7.00**
HEAT SHRINK TUBING – Pack approx 15 x 16 inch lengths. Different diameters & colours	**£3.00**
HARDWARE PACKS – Same quality & quantity as the packs we do at all the major radio rallies – small nuts & bolts, **£3.50**; small self tapping screws, **£3.50**; ring & spade crimp terminals - insulated	**£3.50**
3M STICKY PROTECTIVE FEET – grey rubber - sheet of 56	**£3.00**
COPPER CLAD P.C. BOARD – double sided 18" x 10.5" sheet, easy to cut – on thin and flexible fibre glass	**£2.00**
RESETABLE COUNTERS – 6 digit panel mount inc. catalogue data; 12V DC.....**£6.00**; 240V AC	**£6.00**
TA-XI CMOS SAFE CONTINUITY PROBE – detects & locates short circuits with variable audio tone, easy to use. S.T.C. price £22.00	Our Price **£9.00**
Needs PP3 battery (state if required)	**£0.80**
BRIEF-CASE TYPE CARRYING CASE – used but in good condition, approx. 13½" wide x 8½" deep x 8" high	**£7.00**

POSTAL CHARGES: Orders £1 to £10 - £2.00; £10 to £20 - £4.00
LARGER ORDERS RING FOR CARRIAGE COST

PLEASE ADD 17½% VAT TO TOTAL COST INCLUSIVE OF POSTAL CHARGES

PHONE
0222 831547

RICH ELECTRONICS
Dept. E.E. The Warehouse, Windsor Place, Senghenydd,
Mid-Glam, S. Wales CF8 2GD

FAX
0222 830022

CAMBRIDGE COMPUTER SCIENCE LIMITED

3.5" 720K Diskette Drives	**£29.00 each**
10MByte Winchesters, used, 3 months Wty,	**£35.00 each**
5.25" Disk Drives, 80 Tk, DSDD	**£25.00 each**
5.25" Disk Drives, 80 Tk, DSDD, Used, No Wty (£15.00 drives sold on strictly "as is" basis)	**£15.00 each**
5.25" Disks, DSDD, 48tpi, boxes of 10 (free disk cleaner with 5 boxes)	**£3.00/box**
Lockable diskette boxes for 80* 3.5" or 100* 5.25" (state which)	**£5.99 each**
Small sized diskette boxes (lockable)	40* 3.5" **£4.75,** 50* 5.25" **£4.99**
Printer stands (suit 80/132 cols)	Basic **£2.99,** or with paper catcher **£10.99**
Digital multimeter, 14 ranges, inc leads & manual	**£16.00 each**
Apricot Disk drive PSU	**£10.00 each**
5V at 6A PSU	**£4.80 each**
5V at 10A PSU	**£6.40 each**
Ni-Cads **AA £0.89, C £1.99, D £2.09, PP3 £4.99**	Universal charger **£5.99 each**
Disk Drive Data lead BBC Micro to Disk Drive(s)	**Single £2.00 Dual £4.00 each**
Disk Drive Power lead BBC Micro to Disk Drive(s)	**Single £2.00 Dual £4.00 each**
74LS TTL, pick and mix, buy 10 or more for	**£0.12 each**
Types available: '00 '02 '04 '08 '10 '11 '12 '13 '14 '15 '20 '21 '26 '27 '30 '32 '33 '37 '38 '42 '74 '83 '85 '86 '96 '107 '109 '122 '125 '132 '136 '138 '139 '145 '151 '153 '157 '158 '160 '162 '163 '164 '165 '174 '191 '193 '240 '253 '257 '260 '298 '353 '365 '366 '373 '385 '390 '399 '670 '682	
27128 EPROMS (Ex equipment)	**£1.20 each or £5.00/5**
256K Byte DRAM Modules, removed from equipment	**£6.00 each**
6264-12 8K Byte SRAM	**£3.80 each**
62256-10 32KByte SRAM	**£5.00 each**
65256 32K Byte rams	**£4.00 each**
8K Byte NV ram chips **£3.00 each**	**£10.00 four**

Range of Aluminium & plastic project boxes (ask for list)

Prices include postage. Add 50p (plus VAT) to orders below £5.00. All items new unless stated.
Add 17.5% VAT to all prices. Send an SAE for our latest list or for more info.

Dept EE, 374 Milton Road, Cambridge CB4 1SU
Tel: 0223 424602, 0831 430496 or 0831 430552 (Please note mail order only)

SHERWOOD ELECTRONIC COMPONENTS
45 Rutland Street, Mansfield, Notts NG18 4AP

£1 Special Packs – Now even better value. Select 1 pack FREE for every 10 purchased

SP1	15 x	5mm Red Leds
SP2	15 x	5mm Green Leds
SP3	12 x	5mm Yellow Leds
SP6	15 x	3mm Red Leds
SP10	100 x	1N4148 diodes
SP11	30 x	1N4001 diodes
SP12	30 x	1N4002 diodes
SP18	20 x	BC182 transistors
SP19	20 x	BC183 transistors
SP20	20 x	BC184 transistors
SP23	20 x	BC549 transistors
SP24	6 x	Cmos 4001
SP25	5 x	555 timers
SP26	5 x	741 Op-amps
SP28	6 x	Cmos 4011
SP29	4 x	Cmos 4013
SP31	5 x	Cmos 4071
SP33	5 x	Cmos 4081
SP36	25 x	10uf/25V radial caps.
SP37	20 x	100uf/35V radial caps
SP38	25 x	47uf/25V radial caps.
SP39	12 x	470 uf/16V radial caps
SP42	200 x	Mixed 0.25W C.Film resistors
SP44	12 x	5mm Leds–4 ea. Red, Grn., Yel.
SP46	20 x	400mW zener diodes
SP48	15 x	Axial caps
SP102	20 x	8 pin DIL sockets
SP103	15 x	14 pin DIL sockets
SP104	15 x	16 pin DIL sockets
SP105	6 x	74LS00
SP106	6 x	74LS02
SP110	5 x	74LS13
SP112	6 x	Cmos 4093
SP113	12 x	1N5400 diodes
SP119	6 x	Cmos 4072
SP121	8 x	Rect. Red Leds 5 x 2mm
SP122	8 x	Rect. Green Leds 5 x 2mm
SP123	5 x	Rect. Yellow Leds 5 x 2mm
SP124	20 x	Assorted ceramic disc caps
SP125	10 x	1000uf/16V radial caps

All new and full spec. components

1992 Catalogue now available £1 Contains vouchers redeemable against orders

Cheques or P.O. to **NO VAT** Please add £1 P&P to all orders
SHERWOOD ELECTRONIC COMPONENTS

NEW FROM HIGH-Q
30 VELLEMAN KITS
Added To Our Range

NOW "130" KITS AVAILABLE
For all Electronic Enthusiasts

Sole UK Importers ●Trade Enquiries contact below

NEW KITS INCLUDE:

CODELOCK
CAR ACCESSORIES
COUNTERS
CAR ALARM
DIMMERS
HOUSEHOLD APPLICATIONS
POWER SUPPLIES
SENSORS
AUDIO
DIGITAL CONTROLLED PRE-AMPLIFIER
TIMERS
COMMUNICATIONS
1-CHANNEL INFRA-RED RECEIVER
ALARMS
LIGHT-EFFECTS
COMPUTER INTERFACE
MEASURING DEVICES
GADGETS
15-CHANNEL INFRA-RED TRANSMITTER

For 1991 Catalogue & Price List, please sent 75p (UK) or £2.00 (Overseas) to:

HIGH-Q-ELECTRONICS
VISA
P.O. BOX 142, Hatfield, Herts AL9 7JH
Tel: 0707 263562 Fax: 0707 276746

OMNI ELECTRONICS

174 Dalkeith Road, Edinburgh EH16 5DX 031 667 2611

A COMPREHENSIVE RANGE WITH SERVICE SECOND TO NONE

Do you have your copy yet?

OUR MUCH EXPANDED, BETTER ILLUSTRATED CATALOGUE COSTS £1.50 – INCLUDES VOUCHERS TO USE AGAINST FUTURE PURCHASES. TO RECEIVE A COPY PLEASE SEND YOUR REMITTANCE WITH THE VOUCHER BELOW.

Please send me a copy of the 1990/91 OMNI catalogue.
Payment of £1.50 enclosed

NAME..
ADDRESS..
....
....
TELEPHONE..

Access

Open: Mon.-Thurs.	9.15 - 6.00	
Friday	9.15 - 5.00	
Saturday	9.30 - 5.00	

VISA

PROCOM Electronics

F.M. Wireless microphone	£14.99
Gas Iron	£14.99
Gas Iron Bits	£5.99
25 way 'D' cover	10 for £3.50
12 Volt Relays DPDT	75p 5 for £3.00
12 Volt Relays 4PDT	95p 5 for £4.00
3U Sub-frame racks (flat pack) quantity discount	(£2 p&p) £6.99
2N3055	10 for £4.99
3-16V Piezo Sounders	2 for £1.00
Mercury tilt switch	99p 5 for £4.00
L.E.D. Clock module 12/24 hrs c/w data (mains transformer not supplied)	£2.50
12 Volt Soleniods, (Dim 20mm x 20mm)	95p 10 for £8.00
Philips 9" Colour Monitor (Scart) (S/H)	(£10 p&p) £110.00
Hitachi 9" Mono Monitor (Comp video) (S/H)	(£10 p&p) £49.99
CCD Colour Cameras from (S/H)	(£7 p&p) £225.00
20 Meg Hard Disc Drive M.F.M., low level format (S/H)	(£7 p&p) £85.00
Pocket Multimeter, 14 ranges	£7.99
Multimeter 20k Ω/V Transistor check	£19.99
Digital Multimeter 3½ digit diode check 10A d.c. current	£21.99
Top quality box jointed Japanese long nose pliers	£6.99
Top quality box jointed Japanese oblique cutters	£6.99
Stereo headphone (mini)	£1.99
Hex switches (RS337-093)	£0.75
IEC filtered/fuse carrier chassis plug	£2.00
AA NiCads	4 for £3.60

Seasonal Greetings to our customers

Access

ALL PRICES VAT INCLUSIVE

Access and Visa taken, min. order £5.00

VISA

ALL POSTAGE & PACKING £1.00 (unless otherwise stated)

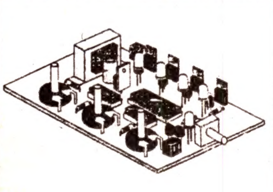
13 Clarence Arcade
Stamford Street
Ashton Under Lyne
Lancashire OL6 7PT

Shop Hours:
Mon-Sat: 9.30 am-6.00 pm
(closed Tues. morning)

Telephone 061-343 2782

TK FOR KITS

DISCO SEQUENCER



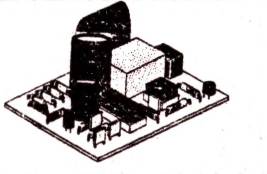
Four channels (up to 1kW each) to drive Rope lights, Pin-spots etc. (Resistive/inductive loads) with 30 different eye-catching sequences. Variable speed and sequence change frequency AND built in audio input. Ideal for mobile or permanent displays. Complete KIT (less box)

XK141 **26.95**

Don't forget our other value for money DISCO KITS

DL8000	8-channel 80 programme sequencer	**46.95**
DL3000	3-channel sound to light	**21.95**
XK124	High power strobe with audio input	**17.95**
XK139	4-channel sequencer	**14.50**

SINGLE CHANNEL INFRA RED REMOTE CONTROL



A simple yet highly versatile Infra Red remote control kit with a multitude of uses in the home or car. Operates from 9-15V dc or 240V ac and switches a 3A relay on and off alternately each time the transmitter is operated at ranges up to 20ft (6m). Responds only to the transmitter frequency. Great for lights, TV, alarm controls etc.

XK134 **11.95**

Suitable transmitter complete with box (9V PP3 battery required)

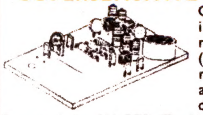
XK135 **5.95**

For more channels use our popular MK12/MK18 IR transmitter receivers

MK9	4-way keyboard	**3.35**
MK10	16-way keyboard	**9.75**
MK12	16 Channel Receiver	**21.95**
MK18	IR Transmitter	**9.75**

SEND 9x6 SAE for our latest KIT LIST which includes details on more exciting kits such as Programmable Lock, Voice Record/Playback, Touch Dimmers, Temperature Controller, etc.

SUPERSENSITIVE MICROBUG

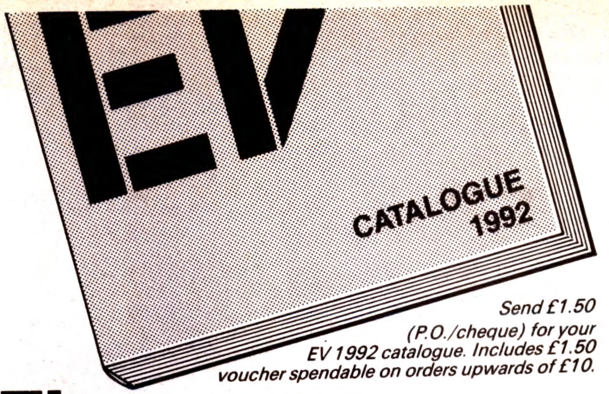


Only 45x25x15mm, including built-in mic. 88-100MHz (standard FM radio). Range approx. 300m depending on terrain Powered by 9V PP3 (7mA). Ideal for surveillance, baby alarm etc. **XK128** **7.25**

ORDERING INFORMATION. Prices INCLUDE VAT but please add 1.25 P&P (UK). Overseas Customers: divide total order by 1.175 then add P&P: Europe 3.50, elsewhere 10. Send PO/cheque/VISA /MASTERCARD No. with order. GIRO NO. 529314002. Local Authority and education orders welcome. Office Hours: Mon-Fri. 9.30 am - 5 pm. Shop Hours: Tues.-Thurs. 10 am - 5 pm Sat. 10 am - 1 pm.

ORDERS: 081 - 567 8910 24 HOURS

TK ELECTRONICS 13 BOSTON ROAD, LONDON, W7 3SJ.



Send £1.50 (P.O./cheque) for your EV 1992 catalogue. Includes £1.50 voucher spendable on orders upwards of £10.

The CATALOGUE

120 pages, A4. Expertly presented and illustrated. Easily referred to. Packed with valuable information.

The COMPONENTS

As wide a choice as you could wish – semiconductors, surface mounting, opto-electronics, Rs & Cs, etc. Top quality; fairly priced.

The SUPPLIERS

Siemens, Boss, Cliff, Omeg, Lorlin, R.S., Uniross, etc. – to our top quality standards.

The SERVICE

Prompt, personal, with customer satisfaction guaranteed. Access/Visa facilities.

ElectroValue

28(A) St. Jude's Road, Englefield Green, Egham, Surrey TW20 0HB.
Phone – 0784 433603 Fax – 0784 435216

MISCELLANEOUS ITEMS

Camera returns; 35mm Auto Flash/ Wind-on, minor faults	£6.00 ea
or 2 for	£10.00
Dictaphone cassette, mech/record erase playback heads, 6V solenoid, motor, hall effect switch	£2.00 ea*
T.V./Printer stands	£3.95 ea
Bicc-Vero Easiwire construction kit	£4.95 ea*
TTL/CMOS short circuit snooper	£4.95*
Dot matrix LCD 10x2 lines	£3.75 ea*
Dot matrix LCD 16 x 1 lines with Data	£4.95*
2 digit 16 segment VF display with data	£2.95 ea*
4 digit intelligent dot matrix display	£6.00*
17 segment V.F. display with driver board and data	£2.99 ea*
8 digit liquid crystal display	£1.75 ea*
4 digit LCD with 7211 driver chip	£3.50 ea*
Digital clock display	£2.50*
11 key membrane keypad	£1.50 ea*
Keyboard 392mm x 180mm/100 keys on board + LCD + 74HC05/80C49 easily removable	£4.95
19" 3U sub rack enclosures	£8.95
12V stepper motor, 48 steps per rev, 7.3° step angle	£3.95 ea*
Stepper motor board with 2 slotted opto + 2 mercury tilt switches	£3.95 ea*
1000 mixed ¼ watt 1% resistors	£4.95 ea
250 electrolyic axial + radial caps	£4.95 ea
100 Mixed trimmer caps popular values	£4.95*
50 off MC 78M12CT Volt Regs	£2.95*
20 off W02M Volt Regs	£1.50*
Cable box UHF modulator/video preamp/transformer/R's + C's/leads	£6.95
1000 off mixed Multilayer Ceramic Caps	£7.95
Solar cell modules 0.45V 700mA	£2.95 ea*
B.B.C. Micro to disc drive lead	£1.50*
Car Burglar alarm vibration auto entry/exit delay	£5.95 ea*
Single zone alarm panel auto entry/exit delay housed in domestic light socket	£9,95 ea*

P.S.U.'s, TRANSFORMERS, COMPONENTS

P.C. P.S.U. 50 watt 115-230V input +5V 4A +12V 2.5A output with built in fan, IEC inlet + on off	£9.95 ea
ASTEC 60 Watt 115/230V input/outputs +5V 3.75A +12V 1.5A −12V 0.75A cased IEC inlet on/off switch	£12.95
STC P.S.U. 240V input 5V 6A output (converts to 12V 3A details available)	£5.95 ea
240V input 5V 10A output (converts to 12V 5A no details)	£5.95 ea
600Ω line output transformers	£1.25 ea*
240V in 0-12V 0.75A out transformer	£1.75*
240V in 0-28V 62VA out transformer	£2.75
Transformer + PCB gives 2x7.5V 32VA with skt for 5 or 12V regulator, will power floppy drive	£3.75 ea
Ultrasonic transducers (transmit + receive)	£1.50 pair
3 to 16V Piezoelectric sounders	50p*
9VDC electromechanical sounder	50p*
24V DC electromechanical sounder	50p*
2A 250V keyswitch 3 position key removable in two positions	£1.50*
DIL switches PCB MT 3/4/6 way	35p*
5V SPCO SIL reed relav	40p*
5V 2PCO DIL miniature relay	60p*
12V 2PCO or 4PCO continental relay	60p*
12V 10A PCB MT (to make contact) relay	95p*
100 UA panel meter	£1.00 ea*
3 to 12V electro magnetic acoustic transducer with data	75p*
2.4576/8.8329/21.10 MHz crystals	50p ea*
Bridges 25A 200V	£1.00*
2A 100V	50p*

QUANTITY DISCOUNTS AVAILABLE PLEASE RING

ALL PRICES INCLUDE V.A.T.
PLEASE ADD £2.00 p&p EXCEPT ITEMS
*MARKED * WHICH ARE 50P*
SAE FOR BULK BUYING LIST
TRADE ONLY
PAYMENT WITH ORDER TO

Dept EE, COMPELEC,
11 Windsor Close,
St. Ives, Huntingdon,
Cambs PE17 6DW
Tel/Fax: 0480 300819

LOW COST UHF RADIO SWITCHING

AS USED BY THE PROFESSIONAL SECURITY MARKET

Incorporating the latest **Surface Acoustic Wave** technology, the system consists of a small "zero-power", UHF transmitter with digital encoder and a UHF receiver unit with digital decoder and 3 relay outputs, 2 alternate and 1 momentary.
8-way DIL switches on both boards set the unique security code. Many applications including lighting, alarms, the "automatic home", etc.

Size:	Tx 45 x 30mm	Rx 55 x 65mm
Supply:	Tx 3-12V	Rx 5-12V
Range	Up to 200m	

Complete System (2 kits)..**£29.99**
Individual Transmitter..**£15.99**
Individual Receiver..**£19.99**

Please allow 28 days for delivery
Cheques/POs to:

BLB Electronics

341 Darwen Road, Bromley Cross, Bolton BL7 9BY

IF AN
ADVERT IS WRONG,
WHO PUTS IT RIGHT?

We do. The Advertising Standards Authority ensures advertisements meet with the strict Code of Advertising Practice.

So if you question an advertiser, they have to answer to us.

To find out more about the ASA, please write to
Advertising Standards Authority,
Department X, Brook House,
Torrington Place, London WC1E 7HN.

ASA

This space is donated in the interests of high standards in advertisements.

ADVERTISERS INDEX

AKULA SYSTEMS......829
AUTONA......781
N. R. BARDWELL......828
BK ELECTRONICS......799/Cover (iii)
BLB ELECTRONICS......832
BULL ELECTRICAL......Cover (ii)
CAMBRIDGE COMP. SCIENCE......830
CIRKIT DISTRIBUTION......819/823
COMPELEC......831
CRICKLEWOOD ELECTRONICS......789
CROTECH INSTRUMENTS......759
CR SUPPLY COMPANY......825
ELECTRONIZE DESIGN......823
ESR ELECTRONIC COMP......803
ELECTROVALUE......831
HART ELECTRONIC KITS......813
HIGH-Q-ELECTRONICS......830
HILLS COMPONENTS......789
HOBBYKIT......754
ICS......829
JAYTEE ELECTRONIC SERVICES......823/825
JPG ELECTRONICS......828
K M ELECTRONICS......829
LITESOLD......819
MAGENTA ELECTRONICS......760/761/762
MAPLIN ELECTRONICS......Cover (iv)
MARAPET......781
MARCO TRADING......758
MAURITRON TECH. SERV'S......828
NATIONAL COLLEGE OF TECHNOLOGY......829
NORTECH ELECTRONIC......819
NUMBER ONE SYSTEMS......825
OMNI ELECTRONICS......830
PANRIX ELECTRONICS......781
PROCOM ELECTRONICS......831
RACKZ PRODUCTS......830
RADIO & TV COMPONENTS......777
RICH ELECTRONICS......830
SERVICE TRADING CO......829
SHERWOOD ELEC. COMP......830
SUMA DESIGNS......778
TECHNICAL INFO. SERVICES......829
TK ELECTRONICS......831
TSIEN......773
TYPESETTING BUREAU......832
VIEWCOM ELECTRONICS......756/757

Typefit

THE TYPESETTING BUREAU LTD

PC page make-up software and typesetter output bureau

6 Church Street, Wimborne
Dorset BH21 1JH
Tel: (0202) 882299
Fax: (0202) 841692
Modem: (0202) 882270
DX: 45314 Wimborne

"For serious document production it knocks other DTP software into the proverbial cocked hat."

Those are the words of Jim Tyler, an independent journalist after reviewing Typefit for "Micro Computer Mart". His letter to us went on to say:

"I spent two years editing a magazine, I have been involved in running a DTP bureau and I currently make my living writing classic car restoration manuals for a division of Reed Business International. I would choose Typefit for any of these roles."

No we did not pay him anything – he did not even get a free copy of our software (Typefit only costs £225 + VAT anyway). And just for the sceptics he is not a personal friend, relative or shareholder in the company.

His sentiments are backed up by our customers, some of which have changed from other well-known DTP packages costing much more – they tell us Typefit is more versatile and provides them with use of a better range of quality typefaces (230 different fonts).

With Typefit you do your own Typesetting, proof and correct your work, we provide the expensive phototypesetter and fonts to give you top quality 2000 dot per inch bromide output.

Before investing in any other DTP package and especially before spending a small fortune on a specialist typesetting computer or other equipment, please investigate Typefit.

Please send me more information on Typefit

Name..

Address:..

....

................................Post Code...................................

Tel:...EE12

Published on approximately the first Friday of each month by Wimborne Publishing Ltd., 6 Church Street, Wimborne, Dorset BH21 1JH. Printed in England by Benham & Co. Limited, Colchester, Essex. Distributed by Seymour, Windsor House, 1270 London Road, Norbury, London SW16 4DH. Sole Agents for Australia and New Zealand –Gordon & Gotch (Asia) Ltd., South Africa –Central News Agency Ltd. Subscriptions INLAND £18.50 and OVERSEAS £23 (£40.50 airmail) payable to "Everyday Electronics" Subscription Department, 6 Church Street, Wimborne, Dorset BH21 1JH. EVERYDAY ELECTRONICS is sold subject to the following conditions, namely that it shall not, without the written consent of the Publishers first having been given, be lent, resold, hired out or otherwise disposed of by way of Trade at more than the recommended selling price shown on the cover, and that it shall not be lent, resold, hired out or otherwise disposed of in a mutilated condition or in any unauthorised cover by way of Trade or affixed to or as part of any publication or advertising, literary or pictorial matter whatsoever.

OMP POWER AMPLIFIER MODULES-TURNTABLES-DIMMERS-LOUDSPEAKERS-19 INCH STEREO RACK AMPLIFIERS

★ PRICES INCLUDE V.A.T. ★ PROMPT DELIVERIES ★ FRIENDLY SERVICE ★ LARGE (A4) S.A.E., 50p STAMPED FOR CATALOGUE ★

OMP MOS-FET POWER AMPLIFIERS
HIGH POWER, TWO CHANNEL 19 INCH RACK

THOUSANDS PURCHASED BY PROFESSIONAL USERS

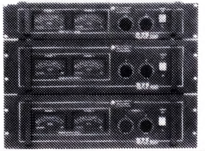
THE RENOWNED MXF SERIES OF POWER AMPLIFIERS

FOUR MODELS:- **MXF200** (100W + 100W) **MXF400** (200W + 200W) **MXF600** (300W + 300W) **MXF900** (450W + 450W)

ALL POWER RATINGS R.M.S. INTO 4 OHMS, BOTH CHANNELS DRIVEN

FEATURES: ★Independent power supplies with two toroidal transformers ★ Twin L.E.D. Vu meters ★ Level controls ★ Illuminated on/off switch ★ XLR connectors ★ Standard 775mV inputs ★ Open and short circuit proof ★ Latest Mos-Fets for stress free power delivery into virtually any load ★ High slew rate ★ Very low distortion ★ Aluminium cases ★ MXF600 & MXF900 fan cooled with D.C. loudspeaker and thermal protection.

USED THE WORLD OVER IN CLUBS, PUBS, CINEMAS, DISCOS ETC.



SIZES:- MXF200 **W19″xH3½″ (2U)xD11″**
MXF400 **W19″xH5¼″ (3U)xD12″**
MXF600 **W19″xH5¼″ (3U)xD13″**
MXF900 **W19″xH5¼″ (3U)xD14¾″**

PRICES:- MXF200 £175.00 MXF400 £233.85
MXF600 £329.00 MXF900 £449.15
SPECIALIST CARRIER DEL. £12.50 EACH

OMP VARISPEED TURNTABLE CHASSIS

★ Manual arm ★ Steel chassis ★ Electronic speed control 33 & 45 R.P.M. ★ Vari pitch control ★ High torque servo driven DC motor ★ Transit screws ★ 12″ die cast platter ★ Neon strobe ★ Calibrated balance weight ★ Removable head shell ★ ½″ cartridge fixings ★ Cue lever★ 220/240V 50/60Hz ★ 390x305mm ★ Supplied with mounting cut-out template.

PRICE £61.30 + £3.70 P&P

OPTIONAL MAGNETIC CARTRIDGES **STANTON AL500MkII** PRICE £16.95 + 50P P&P **GOLDRING G950** PRICE £7.15 + 50P P&P

STEREO DISCO MIXER DJ6500

★ WITH ECHO ★

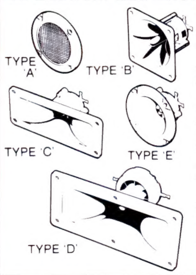
STEREO DISCO MIXER with 2 x 7 band L & R graphic equalisers with bar graph LED Vu meters. **MANY OUTSTANDING FEATURES:- including Echo with repeat & speed control, DJ Mic with tone control & talk-over switch, 7 Channels with individual faders plus cross fade, Cue Headphone Monitor. Useful combination of the following inputs:- 3 turntables (mag), 3 mics, 5 Line for CD, Tape, Video etc.**

Price £134.99 + £5.00 P&P

SIZE: 482 x 240 x 120mm

PIEZO ELECTRIC TWEETERS - MOTOROLA

Join the Piezo revolution! The low dynamic mass (no voice coil) of a Piezo tweeter produces an improved transient response with a lower distortion level than ordinary dynamic tweeters. As a crossover **is not** required these units can be added to existing speaker systems of up to 100 watts (more if two are put in series. **FREE EXPLANATORY LEAFLETS ARE SUPPLIED WITH EACH TWEETER.**



TYPE 'A' (KSN1036A) 3″ round with protective wire mesh. Ideal for bookshelf and medium sized Hi-Fi apeakers. **Price £4.90 + 50p P&P.**

TYPE 'B' (KSN1005A) 3½″ super horn for general purpose speakers, disco and P.A. systems etc. **Price £5.99 + 50p P&P.**

TYPE 'C' (KSN1016A) 2″x5″ wide dispersion horn for quality Hi-Fi systems and quality discos etc. **Price £6.99 + 50p P&P.**

TYPE 'D' (KSN1025A) 2″x6″ wide dispersion horn. Upper frequency response retained extending down to mid-range (2KHz). Suitable for high quality Hi-Fi systems and quality discos. **Price £9.99 + 50p P&P.**

TYPE 'E' (KSN1038A) 3¾″ horn tweeter with attractive silver finish trim. Suitable for Hi-Fi monitor systems etc. **Price £5.99 + 50p P&P.**

LEVEL CONTROL Combines, on a recessed mounting plate, level control and cabinet input jack socket. 85x85mm. **Price £4.10 + 50p P&P.**

OMP LINNET LOUDSPEAKERS

THE VERY BEST IN QUALITY AND VALUE

Made especially to suit today's need for compactness with high output sound levels, finished in hard wearing black vynide with protective corners, grille and carrying handle. Each unit incorporates a 12″ **driver plus high frequency horn for a full frequency range of 45Hz-20KHz. Both models are 8 Ohm impedance. Size: H20″ x W15″ x D12″.**

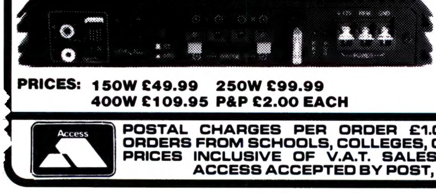
CHOICE OF TWO MODELS

POWER RATINGS QUOTED IN WATTS RMS FOR EACH CABINET

OMP 12-100WATTS (100dB) PRICE £163.50 PER PAIR
OMP 12-200WATTS (200dB) PRICE £214.55 PER PAIR

SPECIALIST CARRIER DEL. £12.50 PER PAIR

IN-CAR STEREO BOOSTER AMPS



PRICES: 150W £49.99 250W £99.99
400W £109.95 P&P £2.00 EACH

THREE SUPERB HIGH POWER CAR STEREO BOOSTER AMPLIFIERS

150 WATTS (75 + 75) Stereo, 150W Bridged Mono
250 WATTS (125 + 125) Stereo, 250W Bridged Mono
400 WATTS (200 + 200) Stereo, 400W Bridged Mono

ALL POWERS INTO 4 OHMS

Features:
★ Stereo, bridgable mono ★ Choice of high & low level inputs ★ L & R level controls ★ Remote on-off ★ Speaker & thermal protection.

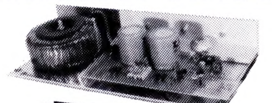
POSTAL CHARGES PER ORDER £1.00 MINIMUM. OFFICIAL ORDERS FROM SCHOOLS, COLLEGES, GOVT. BODIES, PLCs ETC. PRICES INCLUSIVE OF V.A.T. SALES COUNTER. VISA AND ACCESS ACCEPTED BY POST, PHONE OR FAX.

OMP MOS-FET POWER AMPLIFIER MODULES

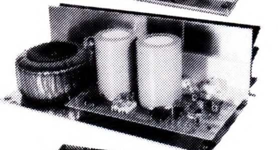
SUPPLIED READY BUILT AND TESTED.

These modules now enjoy a world-wide reputation for quality, reliability and performance at a realistic price. Four models are available to suit the needs of the professional and hobby market i.e. Industry, Leisure, Instrumental and Hi-Fi etc. When comparing prices, NOTE that all models include toroidal power supply, integral heat sink, glass fibre P.C.B. and drive circuits to power a compatible Vu meter. All models are open and short circuit proof.

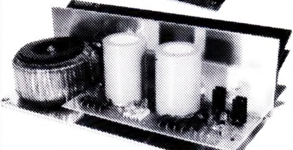
THOUSANDS OF MODULES PURCHASED BY PROFESSIONAL USERS



OMP/MF 100 Mos-Fet Output power 110 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 45V/uS, T.H.D. typical 0.002%, Input Sensitivity 500mV, S.N.R. -110 dB. Size 300 x 123 x 60mm.
PRICE £40.85 + £3.50 P&P



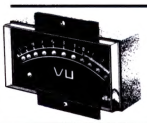
OMP/MF 200 Mos-Fet Output power 200 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 50V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110 dB. Size 300 x 155 x 100mm.
PRICE £64.35 + £4.00 P&P



OMP/MF 300 Mos-Fet Output power 300 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 60V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110 dB. Size 330 x 175 x 100mm.
PRICE £81.75 + £5.00 P&P

OMP/MF 450 Mos-Fet Output power 450 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 75V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110 dB, Fan Cooled, D.C. Loudspeaker Protection, 2 Second Anti-Thump Delay. Size 385 x 210 x 105mm.
PRICE £132.85 + £5.00 P&P

NOTE: MOS-FET MODULES ARE AVAILABLE IN TWO VERSIONS: STANDARD - INPUT SENS 500mV, BAND WIDTH 100KHz. PEC (PROFESSIONAL EQUIPMENT COMPATIBLE) - INPUT SENS 775mV, BAND WIDTH 50KHz. ORDER STANDARD OR PEC.



Vu METER Compatible with our four amplifiers detailed above. A very accurate visual display employing 11 L.E.D.s (7 green, 4 red) plus an additional on/off indicator. Sophisticated logic control for very fast rise and decay times. Tough moulded plastic case, with acrylic tinted front. Size 84 x 27 x 45mm.
PRICE £8.70 + 50p P&P

LOUDSPEAKERS

LARGE SELECTION OF SPECIALIST LOUDSPEAKERS AVAILABLE, INCLUDING CABINET FITTINGS, SPEAKER GRILLES, CROSS-OVERS AND HIGH POWER, HIGH FREQUENCY BULLETS AND HORNS, LARGE (A4) S.A.E. (50p STAMPED) FOR COMPLETE LIST.

P - From McKenzie Professional Series
S - From McKenzie Studio Series

McKENZIE:- INSTRUMENTS, P.A., DISCO, ETC

ALL McKENZIE UNITS 8 OHMS IMPEDANCE

8″ 100 WATT P C8-100GP GEN. PURPOSE, LEAD GUITAR, EXCELLENT MID, DISCO.
RES. FREQ. 80Hz, FREQ. RESP. TO 7KHz, SENS 96dB. **PRICE £31.45 + £2.00 P&P**
10″ 100WATT S C10-100GP GUITAR, VOICE, KEYBOARD, DISCO, EXCELLENT MID.
RES. FREQ. 72Hz, FREQ. RESP. TO 6KHz, SENS97dB. **PRICE £38.89 + £2.50 P&P**
10″ 200WATT S C10-200GP GUITAR, KEYB'D, DISCO, EXCELLENT HIGH POWER MID.
RES. FREQ. 69Hz, FREQ. RESP. TO 5KHz, SENS 97dB. **PRICE £53.21 + £2.50 P&P**
12″ 100WATT P C12-100GP HIGH POWER GEN. PURPOSE, LEAD GUITAR, DISCO.
RES.FREQ. 49Hz, FREQ. RESP. TO 7KHz, SENS 98dB. **PRICE £40.35 + £3.50 P&P**
12″ 100WATT P C12-100TC (TWIN CONE) HIGH POWER, WIDE RESPONSE, P.A., VOICE, DISCO.
RES. FREQ 45Hz, FREQ. RESP. TO 12KHz, SENS 97dB. **PRICE £41.39 + £3.50 P&P**
12″ 200WATT S C12-200B HIGH POWER BASS, KEYBOARDS, DISCO, P.A.
RES. FREQ. 45Hz, FREQ. RESP. TO 5KHz, SENS 99dB. **PRICE £71.91 + £3.50 P&P**
12″ 300WATT S C12-300GP HIGH POWER BASS, LEAD GUITAR, KEYBOARDS, DISCO ETC.
RES. FREQ. 49Hz, FREQ. RESP. TO 7KHz, SENS 100dB. **PRICE £95.66 + £3.50 P&P**
15″ 100WATT P C15-100BS BASS GUITAR, LOW FREQUENCY, P.A., DISCO.
RES. FREQ. 40Hz, FREQ. RESP. TO 5KHz, SENS 98dB. **PRICE £ 59.05 + £4.00 P&P**
15″ 200WATT P C15-200BS VERY HIGH POWER BASS.
RES. FREQ. 40Hz, FREQ. RESP. TO 3KHz, SENS 98dB. **PRICE £80.57 + £4.00 P&P**
15″ 250WATT S C15-250BS VERY HIGH POWER BASS.
RES. FREQ. 39Hz, FREQ. RESP. TO 4KHz, SENS 99dB. **PRICE £90.23 + £4.50 P&P**
15″ 400WATT S C15-400BS VERY HIGH POWER, LOW FREQUENCY BASS.
RES. FREQ. 40Hz, FREQ. RESP. TO 4 KHz, SENS 100dB. **PRICE £105.46 + £4.50 P&P**
18″ 500WATT S C18-500BS EXTREMELY HIGH POWER, LOW FREQUENCY BASS.
RES. FREQ. 27Hz, FREQ. RESP. TO 2KHz, SENS. 98dB. **PRICE £174.97 + £5.00 P&P**

EARBENDERS:- HI-FI, STUDIO, IN-CAR, ETC

ALL EARBENDER UNITS 8 OHMS (Except EB8-50 & EB10-50 which are dual impedance tapped @ 4 & 8 ohm)

BASS, SINGLE CONE, HIGH COMPLIANCE, ROLLED SURROUND

8″ 50watt EB8-50 DUAL IMPEDENCE, TAPPED 4/8 OHM BASS, HI-FI, IN-CAR.
RES. FREQ. 40Hz, FREQ. RESP. TO 7KHz SENS 97dB. **PRICE £8.90 + £2.00 P&P**
10″ 50WATT EB10-50 DUAL IMPEDENCE, TAPPED 4/8 OHM BASS, HI-FI, IN-CAR.
RES. FREQ. 40Hz, FREQ. RESP. TO 5KHz, SENS. 99dB. **PRICE £13.65 + £2.50 P&P**
10″ 100WATT EB10-100 BASS, HI-FI, STUDIO.
RES. FREQ. 35Hz, FREQ. RESP. TO 3KHz, SENS 96dB. **PRICE £30.39 + £3.50 P&P**
12″ 100WATT EB12-100 BASS, STUDIO, HI-FI, EXCELLENT DISCO.
RES. FREQ. 26Hz, FREQ. RESP. TO 3 KHz, SENS 93dB. **PRICE £42.12 + £3.50 P&P**

FULL RANGE TWIN CONE, HIGH COMPLIANCE, ROLLED SURROUND

5¼″ 60WATT EB5-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC.
RES. FREQ. 63Hz, FREQ. RESP. TO 20KHz, SENS 92dB. **PRICE £9.99 + £1.50 P&P**
6½″ 60WATT EB6-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC.
RES. FREQ. 38Hz, FREQ. RESP. TO 20KHz, SENS 94dB. **PRICE £10.99 + 1.50 P&P**
8″ 60WATT EB8-60TC (TWIN CONE) HI-FI, MILTI-ARRAY DISCO ETC.
RES. FREQ. 40Hz, FREQ. RESP. TO 18KHz, SENS 89dB. **PRICE £12.99 + £1.50 P&P**
10″ 60WATT EB10-60TC (TWIN CONE) HI-FI, MULTI ARRAY DISCO ETC.
RES. FREQ. 35Hz, FREQ. RESP. TO 12KHz, SENS 98dB. **PRICE £16.49 + £2.00 P&P**

TRANSMITTER HOBBY KITS

PROVEN TRANSMITTER DESIGNS INCLUDING GLASS FIBRE PRINTED CIRCUIT BOARD AND HIGH QUALITY COMPONENTS COMPLETE WITH CIRCUIT AND INSTRUCTIONS

3W TRANSMITTER 80-108MHz, VARICAP CONTROLLED PROFESSIONAL PERFORMANCE, RANGE UP TO 3 MILES, SIZE 38 x 123mm, SUPPLY 12V @ 0.5AMP.
PRICE £14.85 + £1.00 P&P

FM MICRO TRANSMITTER 100-108MHz, VARICAP TUNED, COMPLETE WITH VERY SENS FET MIC, RANGE 100-300m, SIZE 56 x 46mm, SUPPLY 9V BATTERY.
PRICE £8.80 + £1.00 P&P

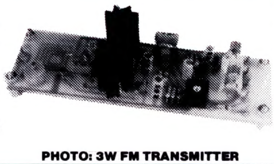


PHOTO: 3W FM TRANSMITTER

B.K. ELECTRONICS

UNITS 1 & 5 COMET WAY, SOUTHEND-ON-SEA,
ESSEX. SS2 6TR.
Tel.: 0702 - 527572 Fax.: 0702 - 420243

1992 BUYER'S GUIDE TO ELECTRONIC COMPONENTS

Maplin

Order your copy of the New MAPLIN Catalogue on sale NOW!
Pick up a copy from any WHSMITH for just £2.75 or post this coupon now to receive your copy for just £2.75 + 20p p&p. If you live outside the U.K. send £4.85 or 14 International Reply Coupons. I enclose £2.95.

Name ....

Address ....

....

Post Code ....

Send to Maplin Electronics,
P.O. Box 3, Rayleigh,
Essex SS6 8LR.

EE92

Over 600 product packed pages wit
more than 600 brand new products
On sale now, only £2.7

Available from all branches of WHSMITH an
Maplin shops nationwide. Hundreds of new produc
at super low price